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EDITORIAL

A SOIL EROSION EXPERT

AT a meeting of the Central Board of Agriculture held in September, 1936, the following resolution was unanimously passed :

> "That this Board recommends to Government the appointment of a whole-time officer to undertake soil erosion investigations and to organize propaganda on this subject."

This resolution was unanimously endorsed by the general committee of the Ceylon Planters' Association at a meeting held on the 25th of September. The Executive Committee of the former body has decided to raise the question again at the next meeting of the Central Board which is expected to be held on the 18th of March. We consider that our readers who are interested in these discussions should have a proper appreciation of the scope of the work that such an officer can usefully undertake.

Soil erosion work may be classed under four heads :

1. Collection of data relating to soil erosion in Ceylon.
2. Experimental work.
3. Study of anti-erosion methods and the publication of authoritative information on such methods.
4. Advisory and propaganda work.

Hardly any work has been done in Ceylon under the first two heads, but such work must precede both the study of soil erosion methods and advisory and propaganda work. The beneficial effects of the better known anti-erosion measures such as contouring, terracing, hedging, and the use of cover crops, and of soil-recapture measures such as silt traps and reverse slope drains have been generally recognized and individual planters have adopted one or more of them with much success. But no organized effort has been made to study the results achieved by them, to co-ordinate these results, to draw general conclusions from them, and to present them to the agricultural public under the authoritative guarantee of a recognized public authority. The soil erosion expert is expected to fill this gap.

The Soil Erosion Committee of 1931 recommended that the field staff of the Agricultural Department should undertake the propaganda and advisory work, and proceeded to make the following suggestion :

> " It considers that the field officers of the Department of all grades should make themselves conversant with the methods of soil conservation set out in this report and that special refresher courses should be held from time to time to enable them to keep abreast of all developments of the subject. It will probably be found necessary to appoint an extra staff officer for soil erosion whose duty it will be to organize the courses recommended and assist the Director of Agriculture and revenue officers and others who may require help."

There is nothing that we can add to this excellent summary of the duties of a soil erosion expert under the fourth head of his functions enumerated above.

STUDIES ON CEYLON SOILS

VIII. THE FERNLAND (KEKILLA) AND SOME DRY AND SEMI-DRY ZONE SOILS

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IN continuation of the studies on the major soil groups of the Island reported in previous issues of this journal (1), attention was directed to a group of soils popularly known as the *kekilla* (fernland) soils, occupying fairly considerable areas in the moist low and mid-country, and to some types or series of dry and semi-dry zone soils. The profile and analytical characteristics of eight of these soils are described and discussed in this article. They comprise two highland *kekilla* soils, one lowland *kekilla* soil, a parkland (*damana*) soil and a reddish brown loam of the semi-dry zone and one each of the grey-brown, chocolate-brown and chocolate-red loams of the dry zone. The analytical determinations were made as before.

THE FERNLAND (KEKILLA) SOILS

The fernlands (*kekillas*) are a characteristic feature of certain low and mid-country areas having an annual rainfall of 100 inches and over. They furnish their best examples in Sabaragamuwa and in certain parts of the Western Province. *Kekilla* lands are generally situated on hill slopes, but low-lying fernlands of small extent do also occur. Their soil depths vary considerably. The surface soil layer of the average type of fernland is a dark humic loam of a depth varying from 2 to 4 inches. Underlying this is a lateritic or laterite loam of reddish yellow to yellowish red colour, containing varying proportions of quartz gravel and undecomposed or partially-decomposed ferruginous concretions. The typical vegetation

consists of the fern *Gleichenia linearis* (S. *Kekilla*), *Hedyotis fruticosa*, *Doona zeylanica* and the grass *Themeda tremula*. On the better class of fernland where the humic layer is of greater thickness (extending to about 12 inches in rare cases) and the underlying soil of appreciably greater depth and in a more advanced stage of decomposition, the large-leaf fern *Nephrolepsis* is the dominant species. Generally speaking, the *kekilla* lands are not suitable for cultivation with annual or chena crops, probably owing to the very acid nature of the soils. There would, however, appear to be no reason why they should not be rendered suitable for this purpose by adequate liming and proper cultivation. Tea and rubber can be grown very successfully on them. They could also probably be utilised for the cultivation of certain timber species and fruit crops.

The fernlands are not infrequently contiguous with high jungle (*mukalana*) on the same hill slope and the lines of demarcation are often clear and regular. This appears to indicate that the fern is a secondary growth having succeeded *mukalana* jungle when the latter was cut down or burnt. The periodic firing of these fernlands would account, partly at any rate, for the stability of their vegetation. On the other hand, the view is held that these fernlands have existed as such within living memory. This does not, however, preclude the possibility that the forest was cut down two or three centuries previously and that it has been superseded by fernland for nearly as long a period.

Notwithstanding the high air temperatures, rainfall conditions obtaining in these fernland areas—steady, almost continuous showers throughout the year—are favourable for the accumulation of humus even on hill slopes, provided the cover of vegetation is good. The variable depth of the surface humic layer, while doubtless related to the nature of the underlying soil, is also connected with the frequency of the firing of the fernlands. With each burn the humus layer is partly destroyed, and in the interval between the burn and the regrowth of the fern, erosion takes its toll. The more frequent the burn therefore, the less the depth of humic soil. The humus accumulation will be the greater, the longer the vegetation is left undisturbed.

Two hillside profiles, one representative of the better class and the other the average fernland, and one lowland *kekilla* profile are described below. Their analytical data are presented in table I.

GOOD HIGHLAND (KEKILLA) SOIL

Location	Liniyawa
Elevation	300-400 ft.
Climate	Rainfall 164 in. ; temperature 80°F.
Geological origin ..	Igneous
Mode of formation ..	Residual
Drainage	Fairly good
Topographic position ..	Hilly (sample midway down slope)
Vegetation	*Gleichenia*, *Nephrolepsis*, etc.

PROFILE

A1. 0-6 in. Blackish brown gravelly loam with abundance of humic material and ferruginous gravel and small boulders ; loose and friable ; amorphous ; root growth good ; horizon boundary distinct.

A2. 6-14 in. Light brown sandy loam with small proportion of humic material ; ferruginous gravel and small boulders in fair proportion ; loose ; irregular prismatic ; roots fair ; horizon boundary fairly distinct.

C. 14 in.-> 3 ft. Yellowish gravelly loam with abundance of ferruginous and quartz gravel and boulders ; compact ; fairly friable ; irregular prismatic to clod ; root growth fair.

AVERAGE HIGHLAND (KEKILLA) SOIL

Location	Bulathsinghala, Pasdun Korale
Elevation	100-200 ft.
Climate	Rainfall > 100 in. ; temperature 80°F.
Geological origin ..	Gneiss
Mode of formation ..	Residual
Drainage	Good
Topographic position ..	(Hilly sample from bottom of slope)
Vegetation	*Gleichenia*, etc.

PROFILE

A.	0-9 in.	Dark brown gravelly loam ; 3 in. of partly decomposed humic material ; concretions in abundance ; loose and friable ; granular ; root growth good ; horizon boundary fairly distinct.
C1.	9 in.-2 ft.	Yellowish grey gravelly loam with fair proportion of undecomposed and partly decomposed reddish ferruginous concretions, giving mottled appearance ; conglomerate; root growth poor.
C2.	> 2 ft.	Hard lateritic material.

LOW-LYING FERNLAND (KEKILLA) SOIL

Location	Homagama
Elevation	20-30 ft. above sea level
Climate	Rainfall 120 in. (approx.) ; temperature 80°F.
Geological origin ..	Recent deposits over Charnockite
Mode of formation ..	Transported (alluvial)
Drainage	Impeded
Topographic position ..	Flat
Vegetation	Ferns, *Hedyotis*, etc.

PROFILE

A.	0-13 in.	Blackish grey sandy loam ; ferruginous gravel in small proportion ; friable ; fairly compact ; granular to small clod ; root growth good.
C.	13 in.-3 ft.	Yellowish grey compact sandy loam with reddish brown decomposing ferruginous concretions and quartz gravel in fair quantity ; small clod to granular ; drainage poor ; water below 3 ft.

TABLE I

	Good Highland Fernland (Kekilla) Soil			Average Highland Fernland (Kekilla) Soil		Lowlying Fernland (Kekilla) Soil	
	A1	A2	C	A	C	A	C
Mechanical Analysis							
Stones and gravel	25·3	5·8	16·8	49·7	50·8	2·4	9·9
Coarse sand	54·2	55·2	56·2	50·1	53·5	60·3	62·0
Fine sand	21·8	21·1	19·5	28·0	25·3	18·6	15·9
Silt	5·1	3·4	3·5	3·1	2·7	3·8	3·8
Clay	15·4	16·6	17·5	13·9	13·9	14·4	13·8
Loss by solution	0·9	0·5	0·6	2·3	1·7	1·1	1·5
Moisture	2·6	3·2	2·7	2·6	2·9	1·8	3·0
Texture index number	14·5	15·5	16·7	13·1	13·0	13·5	12·9
Soil type	Gravelly loam	Sandy loam	Gravelly loam	Gravelly loam	Gravelly loam	Sandy loam	Sandy loam
Chemical Analysis							
Loss on ignition	7·53	6·14	6·24	6·79	6·67	4·71	3·53
Organic matter	3·68	2·36	1·51	5·19	1·38	2·45	·79
Combined water	3·85	3·78	4·73	1·60	5·29	2·26	2·74
Carbon	2·13	1·37	0·87	2·91	0·78	1·40	0·45
Nitrogen	0·113	0·079	0·065	0·091	0·041	0·077	0·035
Carbon/nitrogen ratio	18·8	17·3	13·5	32·2	9·4	18·1	12·7
Reaction	5·1	5·0	4·8	5·0	5·0	4·6	5·1
Total lime	0·099	0·085	0·085	0·028	0·035	0·049	0·028
Total phosphoric acid	0·045	0·048	0·033	0·049	0·050	0·048	0·039
Total potash	0·086	0·094	0·201	0·145	0·151	0·187	0·156
Total exchangeable bases (m.e. per 100 gm. soil)	2·54	2·05	1·02	1·03	0·71	1·08	0·88
Exchangeable calcium	1·09	0·70	0·80	0·78	0·69	0·88	0·69
Exchangeable sodium	—	—	—	—	—	—	—
Clay Analysis							
Loss on ignition	29·87			21·61		25·93	
Silica (SiO_2)	21·74			34·12		33·17	
Sesquioxides (R_2O_2)	45·63			42·39		37·28	
Alumina (Al_2O_3)	30·29			38·35		32·04	
Iron oxides (Fe_2O_3)	15·34			4·04		5·24	
SiO_2/Al_2O_3 (molecular)	1·22			1·51		1·74	
SiO_2/R_2O_3 (molecular)	0·89			1·43		1·58	
Soil type	Laterite			Lateritic		Lateritic	

A comparison of the profile characteristics and analytical data of the average and better quality highland fernland soils will indicate that the humic A horizon is greater in the latter than in the former, being 9 and 14 inches respectively ; the percentages of quartz and ferruginous gravel are much higher in the average *kekilla* soil, while the depth of soil is greater in the better type of fernland. The carbon contents vary from 2·1 to 2·9 per cent. in the A horizons to 0·78 to 0·87 per cent. in the C horizons. The nitrogen contents of all horizons of the better class fernland are higher than those of the corresponding horizons of average fernland. The nitrogen contents of the A1 horizon of the former is fair (·113 per cent.). The C horizons have low percentages of this constituent—·065 and ·041 respectively. The carbon/nitrogen ratios vary from 32·2 to 9·4 in average fernland and from 18·8 to 13·5 in good fernland. The soils are all markedly acid in reaction with pH values varying from 4·8 to 5·1. They are all poor in exchangeable bases, lime, phosphoric acid and to a lesser degree in potash. The better fernlands have however comparatively much higher exchangeable base and lime contents than average fernlands, the figures being respectively 2·5 mgm. equivalent and ·099 per cent. against 1·1 mgm. equivalent and ·028 per cent. in the A horizons. On the basis of the clay analysis of the A horizons, the good fernland has a laterite top soil with a silica/alumina molecular ratio of 1·22 and the average fernland a lateritic top soil with a ratio of 1·51. The former has however a much higher iron oxide content than the latter. It is likely that the C horizons of both types of fernland would have soils of a lateritic nature.

The low-lying fernland differs from the highland fernlands discussed above in having low proportions of stones and gravel in its different horizons. These soils are sandy loams, the texture remaining constant with depth. Like in the highland profiles, the various soil horizons are poor in fertilising constituents, but have even lower carbon and nitrogen contents. In reaction they are again markedly acid. The silica/alumina ratio of the clay complex of the A layer is 1·74, indicating that the soil is lateritic in type.

THE DAMANA SOIL OF THE SEMI-DRY ZONE

The *damanas*, also known as *talawas* in certain districts, are parklands occurring in the dry and semi-dry zones, characterised mainly by the presence of grasses, among others *Chrysopogon aciculatus* (Love grass), *Dactyloctenium aegyptiacum* and *Chloris barbata*, and a few xerophytic low trees and shrubs. The soil proper varies in depth from 3 or 4 in. to 15 or 18 in., but is generally shallow. The underlying strata is semi-decomposed or partly decomposed rock. The profile described below is typical of an area under the Minneriya Scheme which has been considered, if not unsuitable for paddy, at any rate far from ideal for the crop. The grasses die down during the drought, owing to the shallow depth of soil and its low water-retaining capacity. The *damanas* are therefore not suitable as natural pasture lands. They could however be utilised for the growth of fodder grasses under irrigation. Table II furnishes the analytical data of this soil profile.

PARKLAND (DAMANA) SOIL

Location	Minneriya
Elevation	300 ft.
Climate	Rainfall 73 in. (approx.); temperature 81·5°F.
Geological origin ..	Recent deposits over metamorphic rock
Mode of formation ..	Transported (alluvial)
Drainage	Impeded
Topographic position ..	Flat
Vegetation	Grass and xerophytic shrubs

PROFILE

A.	0-8 in.	Greyish brown, friable loam ; compact; small clod ; root growth good.
C1.	9-27 in.	Light brown sandy loam ; hard and compact but friable ; nodular ferruginous concretions ; root growth poor.
C2.	> 27 in.	Decomposing rock.

TABLE II

	Damana Soil		*Reddish Brown Loam*	
	A	C	A	C
Mechanical Analysis				
Stones gravel	11·3	12·8	17·4	25·8
Coarse sand	41·1	37·0	43·8	32·5
Fine sand	38·8	37·6	25·0	27·9
Silt	1·5	3·5	6·7	14·8
Clay	16·2	19·2	20·8	19·7
Loss by solution	0·6	0·5	1·2	1·7
Moisture	1·8	2·2	2·5	3·4
Texture index number	15·1	18·0	19·6	19·3
Soil type	Sandy loam	Sandy loam	Gravelly loam	Gravelly loam
Chemical Analysis				
Loss on ignition	2·91	2·46	4·21	4·33
Organic matter	1·41	0·70	2·41	1·76
Combined water	1·50	1·76	1·80	2·57
Carbon	0·80	0·40	1·39	1·02
Nitrogen	0·078	0·049	0·109	0·080
Carbon/nitrogen ratio	10·3	8·1	12·8	12·8
Reaction	5·9	6·2	6·6	6·4
Total lime	0·273	0·259	—	—
Total phosphoric acid	0·018	0·015	0·060	0·041
Total potash	0·504	0·708	0·320	0·310
Total exchangeable bases (m.e. per 100 gm. soil)	6·13	8·62	10·36	9·83
Exchangeable calcium	4·76	4·82	7·47	7·03
Calcium carbonate	—	—	0·54	0·84
Clay Analysis				
Loss on ignition	20·93		22·10	
Silica (SiO_2)	36·81		45·00	
Sesquioxides (R_2O_3)	40·45		46·04	
Alumina (Al_2O_3)	29·21		29·46	
Iron oxides (Fe_2O_3)	11·24		16·58	
SiO_2/Al_2O_3 (molecular)	2·15		2·59	
SiO_2/R_2O_3 (molecular)	1·71		1·90	
Soil type	Non-lateritic		Non-lateritic	

A glance at this table will indicate that the soil is a sandy loam, its texture becoming slightly heavier with depth. Both A and C horizons are poor in organic matter and nitrogen, acid in reaction, rich in potash and to a lesser degree in lime, but very poor in phosphoric acid. They are fairly rich in exchangeable bases, containing 6·1 and 8·6 mgm. equivalents in the A and C horizons respectively. On analysis of the clay fraction of the A horizon, a silica/alumina molecular ratio of 2·14 is obtained, indicating that the soil is of a non-lateritic nature.

THE SEMI-DRY ZONE REDDISH BROWN LOAM

In the same area as the soil just described, occur large extents of a dark reddish brown free-working loam, of 3 foot depth and greater, carrying low to medium jungle. These soils can be utilised with advantage either for paddy or for fruit cultivation. A typical profile is described below and its analytical characteristics shown for comparison with the previous soil in table II.

THE REDDISH BROWN LOAM

Location	Minneriya
Elevation	300 ft.
Climate	Rainfall 73 in. ; temperature 81·5°F.
Geological origin ..	Recent on metamorphic rocks possibly dolomitic limestone
Mode of formation ..	Transported and residual
Drainage	Satisfactory
Topographic position ..	Flat
Vegetation	Low to medium jungle

PROFILE

A. 0-9 in. Dark reddish brown loam overlain by one inch of humic material ; fair proportion of ferruginous gravel ; fairly hard but friable ; irregular small clod ; slightly acid ; root growth good ; horizon boundary indistinct.

C. 9 in.-> 3 ft. Reddish brown loam; fair proportion of decomposed ferruginous nodules and quartz gravel; irregular clod: slightly acid; root development good.

An examination of the analytical data would indicate that the soils are medium loams, containing a fair proportion of stones and gravel, which increases slightly with depth Unlike the *damana* soils, these are fairly well supplied with organic matter and nitrogen. Their carbon/nitrogen ratios are about 12·8 They are acid in reaction, though not markedly so, rich in exchangeable bases (containing 10·4 and 9·8 mgm. equivalents respectively in the A and C horizons), potash and evidently in lime. Small percentages of free calcium carbonate are noted. Like the *damana* soils, they are poor in phosphoric

acid. The silica/alumina ratio of the clay complex is 2·59 indicating that the soil is non-lateritic in nature. The general similarity in mineral composition of the *damana* and this type of soil would point to the rock from which they are derived being rich in potash and lime and poor in phosphoric acid. There is some indication that the soil composition is influenced to some degree by the dolomitic limestone occurring in close vicinity.

THE DRY ZONE SOILS

THE CHOCOLATE BROWN LOAM

This type of soil occurs in certain parts of the dry zones where the topography permits of the accumulation of alluvial deposits, both mineral and organic. The A horizon is consequently of a distinctly darker colour than the lower horizons. Gravel deposits occur mainly in the C1 horizon. These soils are suitable for the cultivation of dry zone annuals or perennial crops, like citrus, but irrigation is often necessary for the latter. A typical profile taken in the Anuradhapura district is described below and the analytical data shown in table III.

CHOCOLATE BROWN LOAM

Location ..	.. Anuradhapura Experiment Station
Elevation ..	.. 150 ft.
Climate ..	.. Rainfall 55 in. ; temperature 81°F.
Geological origin	.. Recent and possibly dolomitic limestone
Mode of formation	.. Transported (alluvial and possibly residual)
Drainage ..	.. Impeded
Topographic position	.. Flat
Vegetation ..	.. Dry zone crops ; fruits

PROFILE

A.	0-6 in.	Dark chocolate brown sandy loam ; small clod; compact ; hard but friable ; root growth good.
C1.	6-28 in.	Reddish brown loam ; compact but fairly friable ; quartz gravel in fair proportions ; irregular clod approximating columnar structure ; mottlings of grey ferrous oxide.
C2.	28 in.-> 3ft.	Same as C1 but more compact.

TABLE III

	Chocolate Brown Loam			*Chocolate Red Loam*			*Grey Brown Loam*	
	A	C1	C2	A	C1	C2	A	C
Mechanical Analysis								
Stones and gravel	7·0	14·3	7·9	13·6	27·9	17·1	1·4	0·9
Coarse sand	46·3	38·1	30·3	42·2	36·9	43·1	27·8	30·0
Fine sand	31·1	35·8	28·4	23·0	35·3	30·6	36·5	34·4
Silt	4·9	2·3	3·0	5·3	5·3	9·5	14·4	9·2
Clay	14·6	20·8	33·4	22·6	18·7	13·2	16·7	21·6
Loss by solution	1·4	0·8	0·8	2·5	0·6	0·8	1·9	2·2
Moisture	1·7	2·2	4·1	4·4	3·2	2·8	2·7	2·6
Texture index number ..	13·9	19·3	30·6	21·1	17·7	13·0	16·7	20·6
Soil type	Sandy loam	Loam	Heavy loam	Loam	Gravelly loam	Gravelly loam	Sandy loam	Loam
Chemical Analysis								
Loss on ignition	4·47	3·02	4·50	5·10	4·67	4·03	3·62	2·39
Organic matter	3·49	1·09	0·58	2·82	1·25	0·48	1·87	0·67
Combined water	0·98	1·93	3·92	2·28	3·42	3·55	1·75	1·72
Carbon	2·03	0·63	0·34	1·56	0·70	0·27	1·08	0·39
Nitrogen	0·130	0·073	0·066	0·112	0·087	0·028	0·095	0·034
Carbon/nitrogen ratio ..	15·6	8·6	5·1	13·9	12·3	9·9	11·4	11·4
Reaction	7·7	7·7	7·8	8·2	7·5	7·7	6·5	7·2
Total lime	0·473	0·346	0·289	0·317	0·184	0·473	—	—
Total phosphoric acid	0·144	0·108	0·043	0·074	0·048	0·032	0·066	0·056
Total potash	0·515	0·297	0·287	0·164	0·069	0·069	0·470	0·430
Total exchangeable bases (m.e. per 100 gm. soil)	17·05	11·14	14·17	12·98	8·57	16·28	10·24	11·05
Exchangeable calcium	11·57	7·96	8·79	10·38	7·83	15·31	7·37	7·69
Exchangeable sodium	0·68	0·46	0·38	—	—	—	—	—
Calcium carbonate	—	—	—	—	—	—	0·81	0·86
Clay Analysis								
Loss on ignition	24·15	..	..	23·33	..	..	17·88	..
Silica (SiO_2)	34·64	..	..	34·10	..	..	48·10	..
Sesquioxides (R_2O_3)	36·00	..	..	38·03	..	..	43·06	..
Alumina (Al_2O_3)	26·48	..	..	26·80	..	..	30·02	..
Iron oxides (Fe_2O_3) ..	9·52	..	..	11·23	..	..	13·04	..
SiO_2/Al_2O_3 (molecular) ..	2·22	..	..	2·11	..	..	2·72	..
SiO_2/R_2O_3 (molecular)	1·89	..	..	1·79	..	..	2·12	..
Soil type	Non-lateritic	..	..	Non-lateritic	..	..	Non-lateritic	..

The analyses indicate that the surface soil is a sandy loam and that the texture becomes considerably heavier with depth. Thus the clay content increases from 14·6 to 33·4 per cent. from the A to the C horizons. The A horizon is comparatively rich in carbon and nitrogen, but the C horizon is poor in these constituents, particularly the former. The carbon/nitrogen ration decreases from 15·6 to 5·1 with increasing depth. The soils are distinctly alkaline in reaction, and this can be attributed to their very high exchangeable base contents. In this and other respects this soil is very similar to soils derived from limestone and, though the parent rock was not discernable, an examination of the geological map appears to indicate that the soil is, partly at any rate, of limestone origin. The facts that exchangeable calcium constitutes less than 70 per cent. of the total bases and that the exchangeable sodium contents are low, point to the probability of the limestone being of a dolomitic nature. All horizons are rich in total lime and potash and the A and C horizons in phosphoric acid as well. These merely tend to confirm the derivation of the soil from limestone material. The clay analysis reveals that the soil is non-lateritic in nature with a silica alumina ratio of 2·22. On the whole, the analytical evidence is strongly suggestive that this type of soil belongs to the Nalanda crystalline limestone series.

THE CHOCOLATE RED LOAM

Chocolate red loams occur either in the dry or wet zone, where the underlying rock material is limestone, whether crystalline or Miocene. At Vavuniya where this profile was studied the soils are generally deep, well-drained loams with fairly high proportions of ferruginous and calcareous gravel, and are suitable alike for the cultivation of annual crops or perennial crops like fruits, more particularly citrus species. Some form of irrigation is essential for the successful growth of the latter. A typical profile is described below and the analytical data presented in table III.

CHOCOLATE RED LOAM

Location .. .. Vavuniya
Elevation .. .. 50 ft.
Climate .. .. Rainfall 58 in. ; temperature 81°F.

Geological origin	..	Crystalline or Miocene limestone
Mode of formation	..	Residual
Drainage ..	..	Good
Topographic position	..	Very gently undulating
Vegetation ..	..	Rotation crops, citrus species

PROFILE

A.	0-8 in.	Chocolate red loam ; fair proportion of ferruginous gravel ; compact ; hard but friable ; irregular clod to columnar structure ; root growth good.
C1.	8 in.-2 ft.	Reddish gravelly loam with abundance of nodular ferruginous quartz and limestone gravel ; compact ; root growth fair.
C2.	> 2 ft.	Reddish brown rock brash ; with fair proportion of nodular ferruginous quartz and limestone gravel.

An examination of the table shows that the surface soil is a loam, while the B and C horizons are gravelly loams. This should make for good drainage. The A horizon is fairly well supplied with organic matter and nitrogen, but the lower strata are poor in these constituents. In reaction the soils are distinctly alkaline. This is due to the nature of the parent rock material and to the high exchangeable base contents of the soils. These vary from 8·6 to 16·3 mgm. equivalents in the different horizons and is highest in the C2 and lowest in the C1 horizon. Exchangeable calcium comprises over 80 per cent. of the total bases. The total lime contents are high but the potash contents are only fair and the phosphoric acid contents, except in the A horizon, poor. These facts would appear to point to crystalline limestone of the calcite type being the probable parent material from which the soil is derived. On the basis of the silica/alumina molecular ratio of the clay complex, *viz.*, 2·11, the soil is non-lateritic.

GREY BROWN PADDY (GLEY) LOAM

Grey brown light loams under paddy occur fairly extensively in the coastal rice-growing belt of the Eastern Province. Provided they have a plentiful supply of irrigation water, and this is often the case, they grow good crops of paddy, from 30 to 40 bushels

per acre being not uncommon. The sub-soil is a typical *gley* horizon with mottlings and streaks of rust brown in a bluish grey loamy matrix. The morphological characteristics of a typical profile are furnished below and its analytical characteristics shown in table III.

GREY BROWN PADDY (GLEY) LOAM

Location	Sengapaddi in Eastern Province
Elevation	Sea level
Climate	Rainfall 60 in. ; temperature 83°F.
Geological origin ..	Recent
Mode of formation ..	Transported (alluvial)
Drainage	Impeded
Topographic position ..	Level
Vegetation	Paddy

PROFILE

A.	0-6 in.	Greyish brown loam ; cloddy ; compact ; fairly hard ; no concretions ; roots abundant ; slightly acid ; horizon boundary distinct.
C.	6 in.-3 ft.	Bluish grey loam with mottlings and streaks of rust brown (*gley*) ; very compact ; hard ; no concretions ; roots absent ; faintly alkaline.

From the table it will be noted that the surface soil is a light loam while the sub-soil is of heavier texture, the clay percentages being 16·7 and 21·6 respectively. The carbon and nitrogen contents of the A horizons are fair, but the C horizons are poor in these constituents. The surface soil is acid in reaction, but the sub-soil is faintly alkaline. The soils are very rich in potash and evidently in lime, but poor in phosphoric acid. The total exchangeable base content is high for Ceylon paddy soils. Exchangeable calcium constitutes about 70 per cent. of the total bases. A small reserve of free calcium carbonate, in the form of marine shell material, exists in both horizons. The analysis of the clay fraction indicates that the soil is distinctly non-lateritic in nature, the silica/alumina ratio being 2·72.

SUMMARY

In the preceding pages an account is given of the morphological and analytical characteristics of typical profiles of highland and lowland fernland (*kekilla*) soils, of parkland (*damana*) soils and the reddish brown loams of the semi-dry zone and of the chocolate red, chocolate brown and grey brown loams of the dry zone.

REFERENCE

Joachim, A.W.R., Kandiah, S. and Panditteckera, D.G.—Studies on Ceylon Soils. *The Tropical Agriculturist*, Vols. LXXXIV, LXXXV, 1935 & Vol. LXXXVIII, 1937.

THE PROPAGATION OF THE MANGO IN JAFFNA—I

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THERE is no fruit tree in the Jaffna Peninsula held in such esteem as the mango. It has been cultivated from ancient times and is now found in almost every home garden. The fruit holds a reputation for excellence of quality throughout Ceylon but the trade in it is not extensive and much of what is grown is consumed locally. During the season, mangoes in plenty but not of the best quality—as growers retain such for their own use—are sold at the local markets and fairs. The export to other parts of the Island is small because the local demand for good quality fruit cannot yet be met.

In spite of the wide popularity of the mango amongst all classes of people in Jaffna, only a few orchards have been established so far. An increasing interest, however, is now being taken in the cultivation of this fruit on a more extensive scale and varieties are being grown which have been selected specially for quality.

There are numerous varieties of mangoes known in the Jaffna Peninsula, most of which, however, are of poor quality. They are commonly called *pulima* or sour mangoes and are mainly used when immature, in curries and other preparations. The inferior varieties have been grown mainly from seed in old and generally neglected gardens ; the better varieties have hitherto been propagated exclusively by the method of grafting by approach or, as it is more commonly called, inarching.

SOIL AND CLIMATE

The best quality fruit in the Jaffna Peninsula is produced on the red limestone soils of the Jaffna town, the Valigamum North and the Valigamum West Divisions. On the sandy soils of the Tenmaradchy and Pachillapalli Divisions the fruit is of poor flavour. The presence of lime in the soil induces good flavour and, especially, sweetness in the fruit.

The mango tree does not flourish on rocky soils nor on such soils where the sub-stratum contains even soft limestone rock as in the Mathagal-Kankasanthurai area. The tree also requires a particularly well-drained soil for the best development of flowers and fruit.

There should be ample protection, especially during the first seven years after planting, against the strong south-west winds which prevail at certain times of the year.

The Jaffna Peninsula, because of its low-rainfall, is more favourable for mango cultivation than other parts of the Island. Areas of higher rainfall are more conducive to vegetative growth with correspondingly poor flowering. Even in the Peninsula, warm cloudy weather at the time of flowering retards the setting of the fruit and, generally, results in an outbreak of mango hoppers which also damage the flowers and young fruits. At the time of flowering, during January to March, unseasonal rains known as mango showers wash the pollen away from the blossoms and thus prevent the setting of the fruit. There is also a second but minor flowering season from August to October but the fruits produced then are comparatively few and of poor flavour.

PROPAGATION

It is now a common practice in the Jaffna Peninsula for the mango to be propagated by inarching owing to the uncertainty of plants raised from seed coming true to type. Inarching, however, has several disadvantages when compared with other methods of vegetative propagation, such as cleft grafting and the various forms of budding. It uses too much material of the mother tree and, until the union is complete, the stock plant must be kept in a pot and attached, at the point of inarching, to a branch of the mother tree. When

propagation is to be carried out an on extensive scale, large numbers of stock plants have to be kept in pots supported on platforms near the mother tree until the stock and scion have united.

In budding, the material required from the mother tree is less than in grafting as only a small piece of a growing twig containing a bud is taken from the mother tree for budding a stock plant.

In this article, a method of budding devised at the Farm School, Jaffna, and found very successful there is described. This method is now being exclusively adopted on the Experiment Stations of the Division. It is possible to raise large numbers of stock plants in nursery beds where budding can be conveniently undertaken. Budded plants have proved to be more vigorous in growth than inarched or cleft grafted plants.

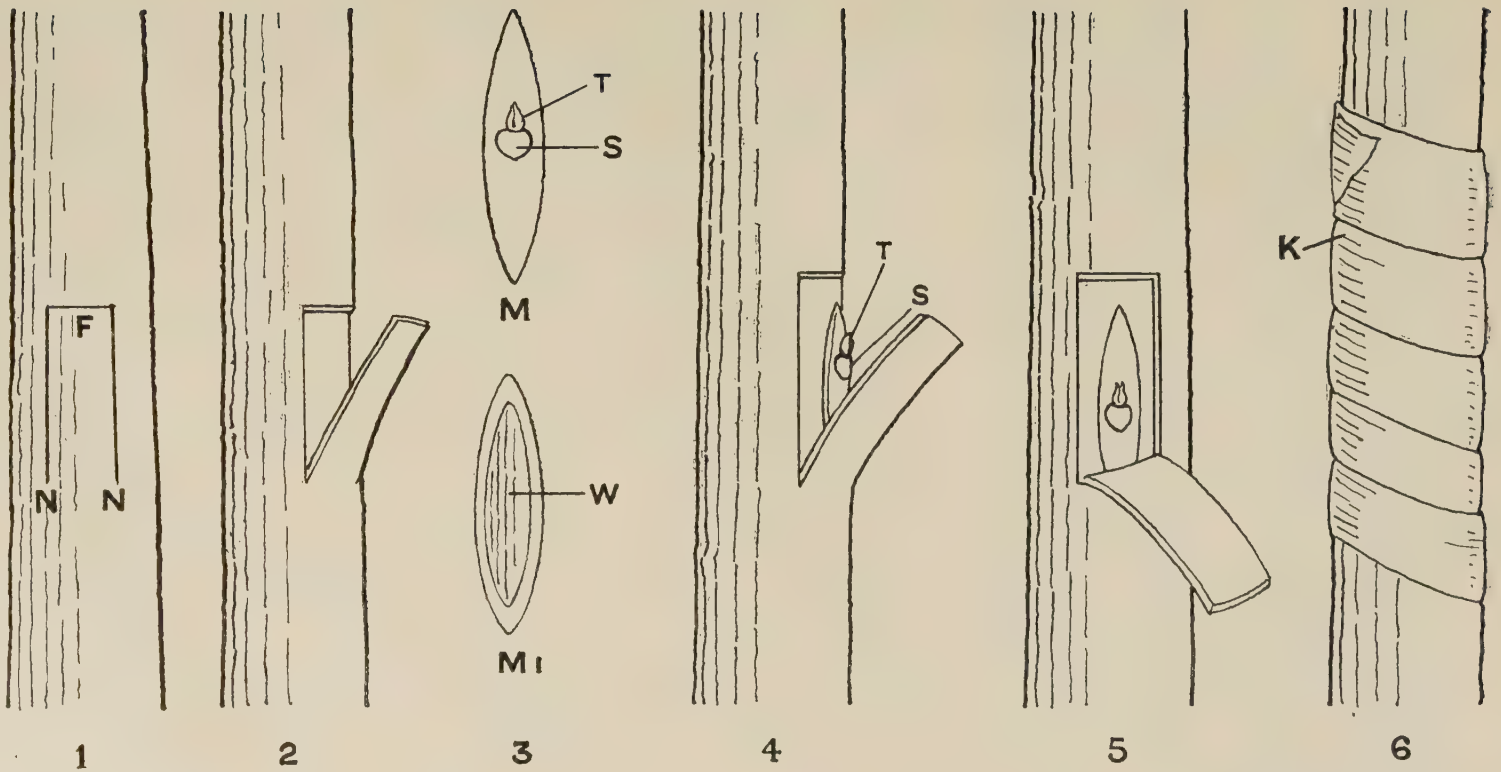
Before budding can be done, it is necessary to grow the stock plants. It is not yet possible to state which variety of stock plant is most suited for each variety of mango to be propagated. Work on this aspect of mango propagation is being pursued at the Farm School, Jaffna, with a number of cultivated and wild varieties of the mango.

Seeds should be germinated without delay after the mature fruit has been picked, as they lose their viability after about a month. Kinman* reported that before germinating the seeds, the hard shell should be removed from the kernel, thereby increasing the percentage germination and reducing the time taken for the germination of the seed. This was confirmed at the Farm School and is now an established practice in laying down nurseries for mango seedlings as stock plants.

It is preferable to plant the seeds in nursery beds at a depth of 3 to 4 inches and at a distance of about 16 to 18 inches apart.

The seedlings should be ready for budding when they attain a diameter of not less than $\frac{1}{2}$ inch at a few inches above ground and this will be when they are six months to one year old. The view is held by horticulturists and others in Jaffna that

*Kinman, C.F.—The Mango in Porto Rico. *Bulletin No. 24, Porto Rico Agricultural Experiment Station*, 1918.



BLOCK BY SURVEY DEPT. CEYLON. 5. 1. 37.

Budding of the Mango

older stock plants are more suitable for inarching in that they give rise to plants which bear earlier, but the writers find that stocks between six months and one year old give more vigorous and earlier bearing plants, when grafted or budded.

The best time for budding is at the end of the monsoon rains but budding can also be done at other times, preferably when the bark can be peeled easily when cut. This occurs during the periodical flushes of growth which last for several weeks. A flush can also be induced to a certain extent at other times by irrigation and manuring. The bark of the stock plant at the point of budding should be brownish or greyish in colour, this condition being reached when the plants are not less than about six months old.

In Jaffna, it is the practice to graft a mango plant high, even at a height of 3 to 4 feet, in order to prevent cattle and goats from eating the leaves of the plant, and under the impression that such plants will bear earlier. Plants which are grafted or budded high are found to be less vigorous than those budded lower, while they are also liable to break at the point of union of stock and scion when they are exposed to strong winds. The most suitable height at which budding should be done is at about 10 to 12 inches from the ground.

In budding, the stem of the stock plant is held firmly in position and a horizontal cut (F) followed by two vertical cuts (NN), about $1\frac{1}{2}$ to 2 inches long, are made in the bark as shown in Fig. 1. The flap which is thus cut is gently pulled down (Fig. 2), leaving a patch of the cambium surface exposed.

The bud or scion should be taken only from twigs of the current season's growth, showing a pale green colour and a smooth surface. The bud is situated just above the leaf-stalk or petiole. Before removal of the bud, the petiole with the leaf attached is severed leaving a small stub, about $\frac{1}{10}$ inch long, attached to the stem. The bud is then cut so that it remains in the centre of a shield about 1 to $1\frac{1}{2}$ ins. in length and of an area which is slightly less than that of the patch left on the stock plant after pulling down the flap of tissue cut in the bark. The cut is so made that a wedge of wood remains underneath the shield. In Fig. 3, the shield with the bud T and the stub of the petiole S is shown at M, while the reverse

view of the shield with the core of wood W is seen at MI. The shield is then placed in the centre of the patch on the stock plant leaving the sides exposed all round as in Figs. 4 and 5. The flap is then pushed up to cover the bud over. Keeping the scion firmly in position waxed tape is then wrapped around it as shown in Fig. 6.

When the weather is hot, a rectangular strip of dry plantain sheath, about 3 ×5 ins. in size, is then tied to the stock plant above and below, thus protecting the bud from desiccation by the excessive heat. During wet weather oil-paper is placed as a cover over the bud to prevent any moisture getting in and thus causing the bud to decay.

After 2 to 3 weeks, the tape may be unwound to examine the bud. If it is still green, it has most probably united. The flap is then cut away and the plantain sheath covering placed over the scion as before to protect it. At the end of another week, the covering is removed and the stock plant ring-barked about $1\frac{1}{2}$ to 2 ins. above the bud.

If there is a flush, the bud should develop in about a week's time and when the shoot has grown to a length of about 3 to 4 ins., the top of the stock should be cut back at the point where it was ring-barked.

When the budded plants are not less than about a foot high, they may be lifted and the tap roots pruned to a suitable length. They should then be potted and, after about a fort-night, they will be ready for transport or planting out in the field.

DEPARTMENTAL NOTES

SOIL EROSION

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This publication was compiled on the suggestion of the Executive Committee of the Central Board of Agriculture that a summary of the Report of the Committee on Soil Erosion (Sessional Paper III of 1931) be published in order to bring this important subject still more prominently to the notice of the agriculturists of this Island.—Ed. T.A.

INTRODUCTORY

The earth is the environment of man and the surface of the earth is the environment of the plant. Man is dependent upon the vegetable kingdom, so that ultimately he is dependent upon the produce of the soil. The soil of Ceylon is the natural capital of the Island and it is vitally important that every effort should be made to preserve it.

Soil erosion is the destructive, crumbling or pulverising action of natural forces, such as rain and wind, on the surface of the earth. It is a process which goes on in all places at all times and at rates which vary according to local conditions. The eroding force of greatest importance in Ceylon is rain, which causes the disintegration of rocks and the movement of soil, while wind is by no means a negligible factor in some districts at certain times of the year. The distribution of rain, its daily intensity and the frequency of short-period downpours of extreme severity, are of most importance. Falls of 15 inches in 24 hours are not rare, falls of 20 inches and over do occur, while in the dry zone a fall of nearly 32 inches has been recorded in 24 hours. It has been established from observations made in widely different parts of the world that practically all the rainfall of a day's heavy rain usually falls within 10, or

even within 7, consecutive hours, while a disproportionately large fraction of that amount falls within 1, 2 or 4 hours. These conditions also apply in Ceylon, and downpours of 4 inches and even more in one hour can be regarded as a practical probability.

For a certain area the eroding forces may be regarded as unalterable, although between different localities these forces show wide variations. The resistance of the land surface to erosion also varies from place to place. It depends mainly upon (i) the type of rock or soil, (ii) the slope of the land, and (iii) the conditions and amount of surface cover. An absorptive soil will have a much greater resistance to erosion than an impermeable soil, and the steeper the slope and the more exposed the surface of the ground or soil, the less will be its resistance to erosion. For a certain area the factors (i) and (ii) are constant, so that alterations in the normal rate of soil erosion are caused by changes in the condition and amount of the surface cover. These changes are invariably due to the removal of the natural forest or grass soil-cover for purposes of cultivation or cattle rearing and its insufficient replacement by permanent crops. The resistance of the soil to erosion is reduced in this way, the necessary breaking-up of the soil for cultivation still further reduces its resistance, while the out-of-date practice of clean-weeding permanent crops, and even in some cases, semi-permanent crops, reduces this resistance till there is none.

EFFECTS OF SOIL EROSION

The results of the processes of soil erosion are of the kinds which may be referred to as internal and external.

The internal results are restricted to the land which is being eroded. The surface soil, which contains the greater part of the nutrient matter and the whole of the organic food of plants, is bodily removed, and with it are lost, not only the actual salts which serve to nourish the plant, but also the micro-organisms which bring these salts into the condition in which they can be used by plants. The fertility of the soil is thus seriously reduced and its physical properties, such as water-retaining capacity, are altered by the destruction of its tilth. This lost fertility of the soil cannot be restored just by the application of artificial manure, as the production of tilth

is a gradual process which is the result of the interaction of several different factors, of which the presence of plant food is only one. The soil, depleted of its most valuable ingredients by erosion, ceases to be able to support the crops grown on it, with the result that even the protection which these crops normally give it is largely lost. Erosion now reaches its second stage. The remaining top soil is washed away bodily ; from the channels formed by the water as it rushes down the slopes, subsoil in scoured away and gullies and ravines develop. The once fertile slopes not only lose all their fertility but the land is left in such a scoured and devastated condition that it is beyond reclamation. In this way the permanent capital of an agricultural country is destroyed.

The external results of erosion are many ; they take various forms and are of a serious nature. One result of the removal of a forest cover is interference with the flow of streams. Water is removed rapidly from unprotected land instead of being temporarily detained. The flow of streams arising in such land becomes irregular, being decreased during fair weather and becoming torrential during monsoon weather. Irrigation channels and rivers become choked by silt carried down from the eroded land, and irrigation works are often destroyed by the rush of water during heavy weather. Agricultural areas below the eroded land, such as paddy fields, may be ruined by the deposition of large quantities of sand and silt. The choking of river beds reduces their sections, with the result that they cannot carry and contain the volume of water they receive, and floods are aggravated. The flooding of roads during monsoon weather with its concomitant inconvenience and danger, and the unremunerative expenditure of public funds on the enlargement of existing, and the construction of additional bridges and culverts for roads and railways, are indications of the magnitude and cost of the evils which soil erosion causes.

The Soil Erosion Committee were of the opinion that external damage caused by internal erosion should be penalized. It is therefore in the interests of the land owner or occupier to cultivate his land in such a manner as to avoid being penalized for external damage.

THE CONTROL OF SOIL EROSION

Soil erosion is caused primarily by the free movement of water on the surface of the ground. It is obvious therefore that the secret of successfully controlling soil erosion is to prevent the movement of any surface water. In practice it is not possible to effect this completely, so that efforts have to be made to reduce to a minimum the speed at which this water moves. It is not generally realised that doubling the velocity of water increases its transporting power sixty-four times.

To reduce soil erosion to a minimum it is necessary to :

1. Protect the soil from the direct erosive action of rain water falling on it.
2. Obtain the maximum absorption of the rain water where it falls.
3. Control the removal of the surplus rain water.
4. Arrange for the collection and replacement of any eroded soil.

It should be the aim of all who undertake any work for the reduction and prevention of soil erosion, to put into practice all the measures necessary to effect the first three of the above to such a degree that the last measure becomes unnecessary.

The primary aim in anti-erosive measures must be *the prevention of the run-off of water.* To effect this it is necessary especially during heavy falls of rain, (*a*) to reduce the force with which rain falls upon the soil surface, (*b*) to retard the rate at which it reaches that surface, and (*c*) to bring about the maximum absorptive capacity of the soil.

Reducing the force with which rain falls upon the surface of the soil involves the establishment of something to cover and protect the soil from the beating action of rain water falling directly on to it. The less the height from which this rain water falls, the less will be its erosive action. The most effective form of protection is some suitable type of low-growing ground cover crop. Plants of high or medium growth, such as are commonly grown for high shade and medium high shade or green manuring respectively, prevent the direct beating action of rain on the soil to a limited extent; but they

do not prevent it so efficiently as do ground cover crops. High and medium shade, *in combination with ground cover crops*, effectively perform function (*b*) ; that is, they retard the rate at which rain water reaches the soil surface, and thus give it time to sink into the ground if the soil is sufficiently absorptive. In the case of crops which are tall or of medium height in growth, the crop itself can in part perform this function.

The direct beating of rain water on the surface of the soil is not the only erosive action which takes place on a bare soil, unless the ground be perfectly level. In Ceylon, even in those parts of the Island where the rainfall is low, the soil surface is rarely perfectly flat over areas of any considerable extent. This being the case a second erosive fact has to be considered, this is the transport or movement of soil particles caused by the flow of water on the surface of the soil. In view of the great transporting power of water, especially in the case of soil particles of diminutive size, this erosive factor is a very important one on all types of soils and even where the slope is so slight that it is not apparent. This erosive factor can be counteracted only by an efficient low-growing ground cover, whatever form that cover may take, whether it be a cover crop, weeds or a natural grass cover. Ground covers, however perfect they may be, cannot entirely prevent the movement of water on the surface of the soil under rainfall of high intensity ; but they do effectively reduce the rate of flow of this water, and so where the absorptive capacity of the soil is high, give it time to sink in or be absorbed.

Ground covers must be regarded therefore, as of primary importance in the prevention of soil erosion since they perform three of the four functions necessary to reduce soil erosion to a minimum. They protect the soil from the direct erosive beating action of rain ; if the soil is in the proper condition they enable it to obtain the maximum absorption of the rain which falls ; and they effectively assist in controlling the removal of surplus rain water by limiting its rate of flow on the soil surface. *The establishment of a satisfactory ground cover, as rapidly as is possible, must be regarded as an imperative necessity for the prevention of soil erosion.* Almost all crops will permit of this, with the exception of a limited number of short-period or seasonal

plants. As regards the latter, the rapid and periodical growth of weeds will serve the purpose of ground covers to a limited extent. In the case of seasonal or other crops in which it is essential that no weed growth be permitted, it should be remembered that the provision and maintenance of a satisfactory surface mulch of organic material which has not entirely lost its original plant structure, can to some extent take the place of a ground cover.

In order to bring about the maximum absorption of rain water by the soil at the place where it actually falls, it is necessary to limit the rate at which this water reaches the surface of the soil to prevent its rapid flow or movement over this surface, and to have the soil in such a condition that its absorptive capacity is at its maximum. The first of these is effectively performed by a satisfactory ground cover, which, as already indicated, in part also assists in the other two.

The rate of movement of water over the surface of the soil irrespective of the presence of a ground cover, will vary mainly in accordance with the degree of slope of the area concerned. The steeper the slope the greater will be the rate of movement and the greater, therefore, the necessity for checking it. Also the steeper the slope and the greater the rate of flow, the less the time available for absorption, with the result the quantity of surplus water that can flow off will be greater. To prevent erosion the free movement of this surplus water must be prevented and its removal controlled. In the past it was customary to lead this water off the land, in so-called drains by the easiest and quickest possible route, and no account was taken of the soil which went with it. More recently, however, the value of this soil has been realised and more and more frequent attempts have been made to prevent its loss and to recover it. To accomplish this it has been necessary to check the rate of flow of this water by flattening the gradient of drains and by constructing in them silt pits and locks and steps. The fact that if surface run-off is prevented there will be no soil movement, is still insufficiently realised. The old idea that drains were required and should be designed to take water off the land as quickly as possible is obsolete. It has been replaced by the modern conception of drains as an

additional means of aiding the maximum absorption of water falling on the land, as a means by which the removal of surplus water can be controlled, and as a means of collecting and returning to the land, silt which has been eroded from the areas above the drains and carried into them by surface water. The Soil Erosion Committee considered that it was possible to control the movement of surface water and stop the downward movement of surface soil by the use of ground cover ; drainage systems are to be regarded as a second line of defence against soil erosion. The first line of defence should be in front of the drains, and it should be efficient enough to render the drains unnecessary in all but the heaviest and most prolonged downpours, or to ensure that the water which finds its way into the drains does not contain silt but is clear and colourless.

Drains are in universal use in tea and rubber plantations, though their dimensions, spacing and gradients vary considerably. The usual width and depth is 18 inches ; the distance between drains varies with the steepness of the slope and with the rainfall, but it is usually between 25 and 35 feet. Gradients vary enormously ; the older type of so-called contour drains were often as steep as 1 in 7, but the average was probably 1 in 20 to 1 in 30. The tendency in recent years has been to reduce the gradient of new contour drains until slopes of 1 in 60 or even 1 in 120 are now found.

Where drains are necessary their construction should be guided by scientific principles, and their size and frequency should be determined by the maximum amount of run-off they may be called upon to hold. It has been urged against deep drains and silt pits that in districts where the soil is of an impenetrable nature, the water percolates very slowly into the ground and in the meantime furnishes breeding grounds for mosquitoes. In such districts it is necessary to make the drains and pits smaller and more frequent.

In recent years various modifications have taken place in existing drains ; silt pits are perhaps the most common and the least efficient. Their effective capacity for the retention of water and the collection of silt is confined to the pits themselves. Once they are full of water they cease for practical purposes to exist ; the water in the drain flows unhindered over them and

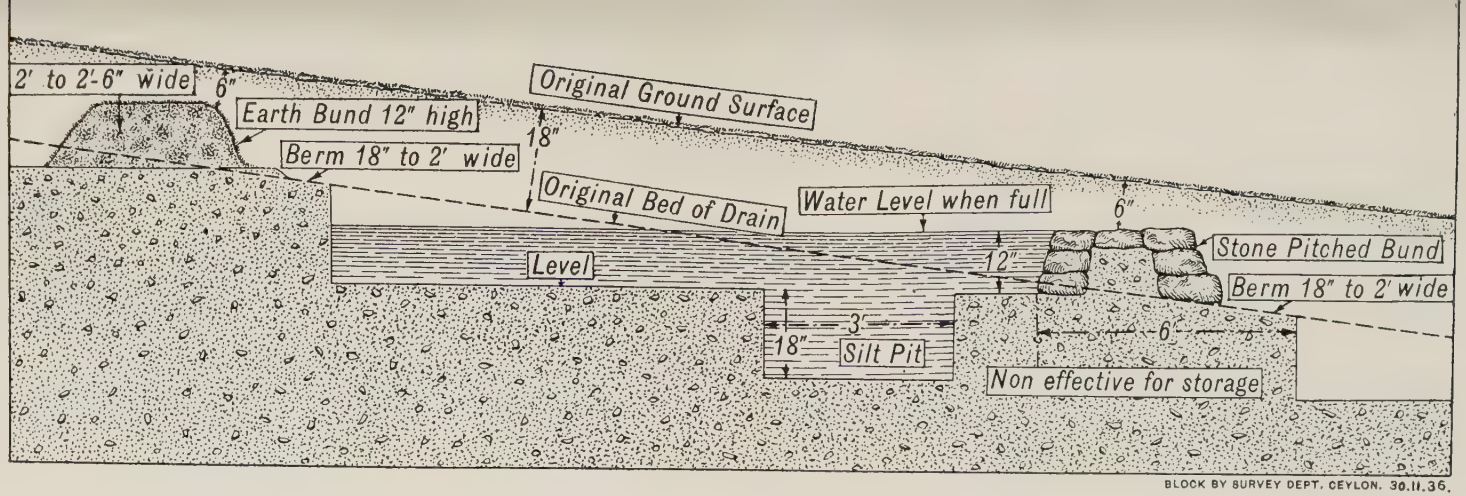

Fig. 1. Mr. C. E. A. Dias' method of regrading steep side-drains

STORAGE CAPACITY OF REGRADED DRAIN

In system as sketched original drains were 25 feet apart, 18″ wide × 18″ deep and graded at 1 : 10. Cross Bunds were constructed 15′ apart and Silt Pits 3′ long × 18″ deep were dug as shown.

Overall length of each 'basin'	= 15′
Effective ,,	= 15′ — 6′ = 9′
Capacity of each basin	= $(9 \times 1 \times 1\frac{1}{2}) + 3 \times 1\frac{1}{2} \times 1\frac{1}{2}$
	= $20\frac{1}{4}$ cubic feet
Length of Drain per acre	= 43,560 ÷ 25
	= 1740 feet
Number of Basins per acre	= 1740 ÷ 15 = 116
Storage Capacity per acre	= 116 × $20\frac{1}{4}$
	= 2,360 cubic feet
	= 0·65 inch Rain

Fig. 2. Side drain (levelled by Mr. Dias' method) photographed after a shower

Fig. 3. Java Silt Pits

with the exception of the very coarse particles carries away any silt with which it may be charged. The fine clay fraction which constitutes the most valuable part of the soil requires 24 hours to settle through 12 inches of still water ; there is no chance of its settling with silt pits full of water and a downward flow of water still in progress.

Cameron's lock and step system, advocated by Mr. E. O. Felsinger, is a distinct improvement ; in effect it results in the conversion of the drain into a series of silt pits separated by narrow walls. A quantity of water equal to the storage capacity of the basin thus formed, is held up in each section and the soil which it carries has an opportunity to settle. It is calculated that this system will hold 2 inches of rain before the spills overflow. There is no reason why the holding up of larger quantities should not be provided for by increasing the dimensions of the drains.

A further improvement, which is subject to the same limitations however, is the following. The drain is divided by bunds as in the lock and step system but the sections between the bunds are excavated so as to be horizontal. The late Mr. C. E. A. Dias evolved this method of regrading existing drains, which obviates the damage and expense caused by cutting drains on new traces. Under this method the old drain is transformed into a series of flat reaches separated by shallow spills, each section having a silt pit at its downstream end (Figs. 1 and 2). By this means the capacity of the system is increased and the forward rate of flow diminished.

On gentle slopes and with an evenly distributed rainfall, the system of bunded catch-water pits advocated in Java may be sufficient to provide for the holding up of all the run-off water. Rows of pits are dug in contour lines across the slope (Fig. 3).

Where main down drains exist for the removal of surplus water they should be improved in such a way as to reduce the rate of flow. A neglected down drain, especially in friable soil, becomes a gully which gradually eats its way into the hill. As the scour develops, it lowers the water-table of the slope and so effects fertility. The lowering of the water-table also results in a decrease of the absorptive power of the soil of the

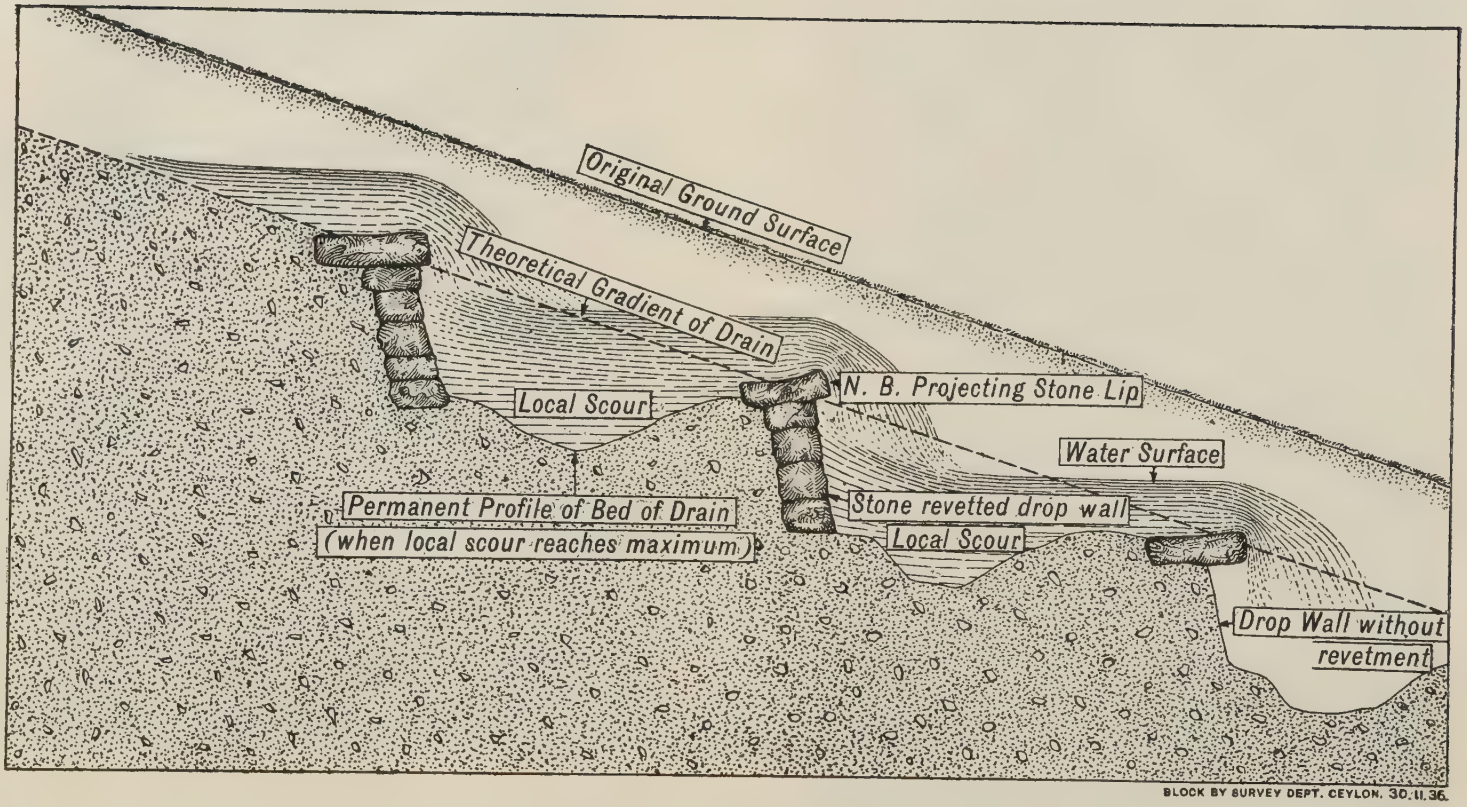

Fig. 4. Mr. Horsfall's step and water cushion system for prevention of scour in main down drains

slope owing to the presence of air at levels which would ordinarily be occupied by moisture. In recent years much time and money has been spent on the treatment of down drains by building revetments and cross walls and by paving their sides and beds. Much has been done also by planting the sides and beds with fern, cheddy and Paspalum grass. These measures, useful as they are, only prevent the scouring of drains ; they do not reduce what is often a roaring torrent to the gentle cascade which is desirable. This can be accomplished by the construction of steps and the formation of water cushions (small steps sloping backwards with a projecting lip of earth or stone) (Figs. 4 and 5); by means of these the rate of flow is reduced to a minimum and the water drops vertically from one step to the next instead of cascading. Mr. A. G. D. Bagot has also devised a useful reverse slope system of reducing the rate of flow and inducing the deposition of suspended silt in open drains. This is accomplished by the construction of a series of steps with a reverse slope along the course of the existing drain (*vide* The Tea Quarterly, 1930, Vol. III, pp. 73-76 and 114-116). This system breaks the continuous downward flow of the contained water at each step and thus allows any suspended soil to settle. When down drains have been eroded to such an extent that they have reached the gully stage, control of the velocity of water can be obtained only by the building of large and expensive cross walls of stone. It is important in cases where main down drains are employed that they should be properly sited in the natural folds on the concave faces of the hill.

Other works which aim at preventing the downward movement of water and soil on slopes, and thus aid in controlling the removal of surplus water, are stone terracing, the construction of contour and individual platforms and contour trench systems.

Much excellent stone terracing has been done on tea and rubber estates and there is no doubt that it does arrest a large amount of downward movement of soil on slopes. The efficiency terraces depend more upon their frequency than on the height of the stone-work, which it is considered, should not be more than 18 inches in height. Occasionally, however, much harm is done by water spilling over the tops of terraces and it is

therefore essential that stone terracing should be supplemented by measures designed to ensure maximum retention and absorption of water falling on the terraces.

A very effective measure for this purpose consists in the planting of a continuous (single row) grass border along the sides, particularly the upper sides, of road and drain edges. These can be established at a very small cost and, in time, grow higher and form a small bund or terrace as soil collects. Several types of upright growing grass are suitable for this purpose, but in all cases they require to be closely planted. *Paspalum dilatatum* is perhaps the most suitable for the purpose, though Guinea and Napier grass have also been used with success. Whatever type is used the grass will always require to be controlled and kept within bounds. The grass cuttings can be used as a surface mulch or fed to stock. On account of less labour being involved and their lower cost a much larger area can be more quickly established in these grass border terraces than can be done in stone. The limits of the usefulness of stone terraces should be recognized. They are not regarded as a complete or efficient method of preventing soil erosion, so that undue reliance should not be placed upon them. Stone terraces are not used in coconut plantations but terraces two feet high constructed of husks are employed. In the cases of terraces of this type on apparently flat land, it has been noted that the soil movement had been sufficient to deposit soil to the level of the top of the bund of husks.

Contour platforms are considered to be a progressive method of opening new clearings and this system has proved its undoubted benefits. In the more advanced 1930-31 rubber clearings opened under this system, only the large timber is removed at first, and lining and holing are done before the land is finally cleared. The construction of the contour platforms is done immediately. The holes are refilled with top soil and the platform is constructed, so that the plant will be in the centre. The earth is removed from above the pegs and built up below them to form a platform. The platform slopes backwards into the hill, the inner edge being at least a foot below the outer. Small buttresses are left at intervals along the back of the platforms so that undue lateral movement

Fig. 5. Mr. John Horsfall's " Step and water cushion system " for main drain

Fig. 6. Contour Platforms in Rubber

Fig. 7. Contour Platforms in Rubber

Fig. 8. Contour Platforms in Rubber showing water held up after heavy rain

of water is prevented. Silt pits are usually dug at the back of the platform, and the platforms are planted with cover crops which form a complete cover except for a space around each tree which is kept clean. There are no drains and the whole of the water falling on the land is absorbed (Figs. 6, 7 and 8).

Individual contour platforms are known to be in use on coconut plantations and a successful type which is easy of construction and effective in use is indicated in Fig. 9.

A contour trench system for opening a tea clearing in patna land has been devised by Mr. C. Du Pré Moore. In this system the grass is not burnt off but is dug in and allowed to rot *in situ*. In this way all the plant material is preserved and soil is protected from the beginning. Level contour trenches are cut and the earth bunded above the trenches and consolidated by beating, the face being reinforced by stone where this is available. In the course of time a terrace is formed and any extensive soil movement is prevented. Lining is done in the ordinary way so that the system is a contour one without the tea being actually planted on the contour. Any wash which takes place is caught by the bund which thus initiates the terrace formation (Figs. 10 and 11). By means of this system all the water falling on the land is absorbed, and any soil movement is limited to the wash on individual terraces from the back to the front. Unless this system is reinforced by the use of a ground cover its use is considered to be limited to gentle and medium slopes.

In the contour trench system evolved by Mr. Denham Till the size of the trenches is first calculated so that they shall be sufficient on any area to contain the run-off water from the probable maximum downpour thereon. A level trench of the required dimensions, usually 3 ft. by 3 ft., is cut at the base of the hill. Assuming that rubber is to be planted in rows 24 feet apart, the next trench, also level and of the same dimensions, is cut 24 feet from the centre of the first one and so on up the hill. The surface soil removed from the trench is thrown to the upper side and the subsoil to the lower side. The subsoil is used to form a bund on the lower side of the trench and creeping or other cover crops are grown on the bund. The trench is not filled in until immediately before planting, when

it is half filled with top soil. Any rain which has fallen between the time of trenching and that of planting will have replaced some of the original surface soil thrown above the trench, and this may be increased by scraping the top soil from the ground above the trench until the requisite depth of soil is obtained. If no cover crop is grown other than that on the bund, local erosion taking place between the trenches will result in the formation of a series of contour terraces.

A good ground cover is of primary importance in the prevention of soil erosion, and the control of free surface water is the next essential.

The measure of next importance is to ameliorate the soil so that it attains its maximum absorptive capacity. The more water that is absorbed by the soil the less there is to run down the hill carrying soil with it. Up to a point, soil absorbs water to its advantage since it also absorbs air. Too much absorption will cause water-logging, but it is extremely unlikely that water-logging will occur to any extent even on gently undulating land except in areas near the coast and where the water-table is already high. On hill sides or sloping land the possibility of water-logging does not require consideration, and the aim should be to absorb the maximum amount of water on such slopes both for the prevention of erosion and for the benefit of the soil itself. The cultivation of the soil is thus a matter of importance as it affects absorption, percolation, and the retention of soil moisture. Deep cultivation is preferable to superficial scraping, but while deep forking has a value in aiding absorption it will not prevent soil erosion. The results of experiments have shown that plain envelope forking increases erosion. It is necessary, therefore, that forking should be supplemented by protection of the surface of the soil and by green manuring. Green manuring leads to the formation of humus which increases the water-retaining capacity of the soil, to the aggregation of soil particles by flocculation, and to the production of tilth. In this connection the advantages of green manures over artificial fertilizers should be noted. The latter add chemical salts to the soil, and their indiscriminate use may lead to the accumulation in the soil of alkaline or acid residues in such quantity that conditions which are adverse

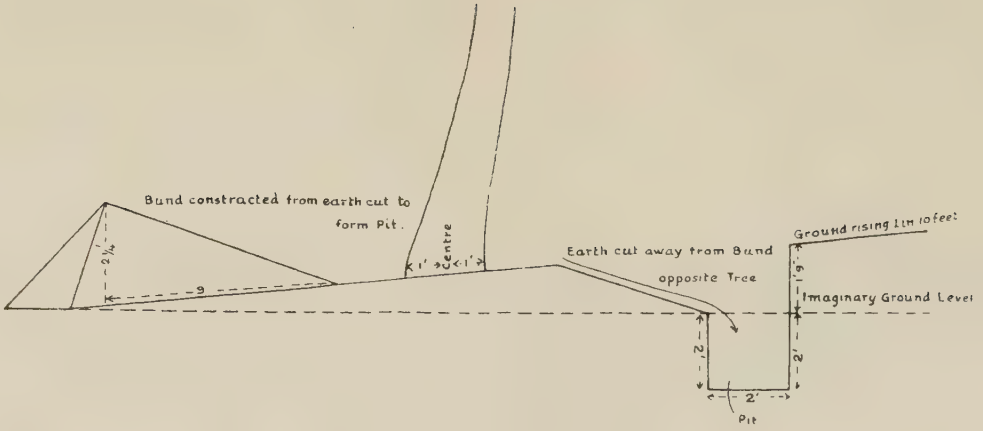

Fig. 9. Individual platforms in coconuts

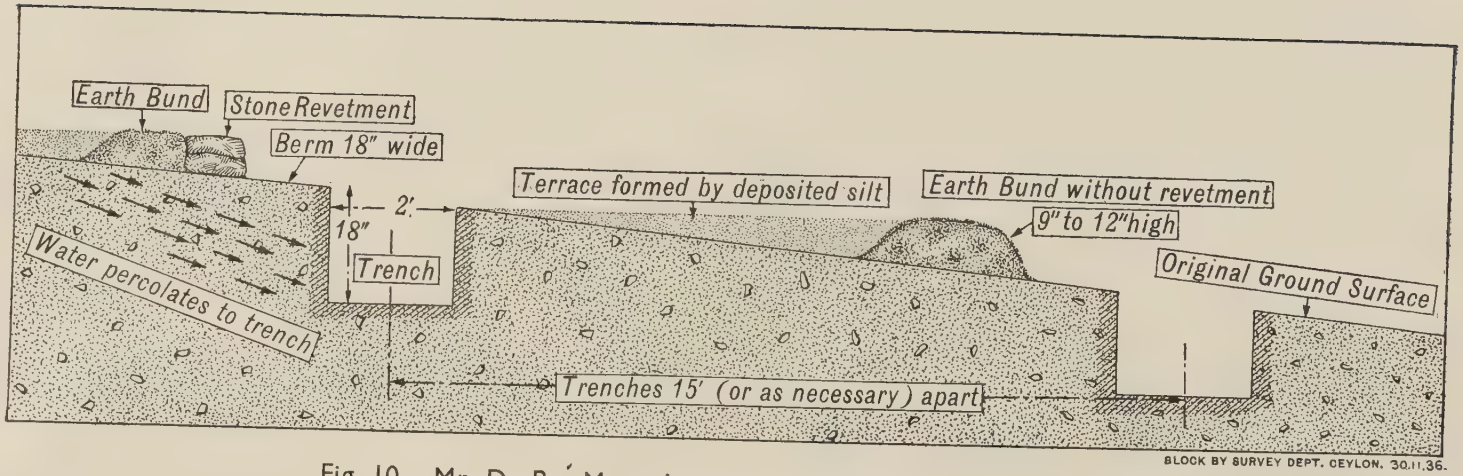

Fig. 10. Mr. Du Pré Moore's catchwater bund and trench system

CAPACITY OF MR. DU PRÉ MOORE'S SYSTEM

With Trenches 2′ *wide* × 18″ *deep* at 15′ appear:—

Length of Trench per acre .. .. = $\frac{43{,}560}{15}$

= 2,900 feet

Capacity ,, ,, ... = $2{,}900 \times 2 \times 1\frac{1}{2}$

= 8,700 cubic feet

= 2·4 inches Rain

or even toxic to the plant may be produced. Green manures, in addition to improving the soil physically, do not have this disadvantage and their presence may counteract the harmful effect produced by excess of artificial manures. For this reason alone the increased use of green manures is advised.

A soil which by exposure to the sun is baked hard on the surface will naturally offer a freer run-off to rain water than one which is kept cool and moist by shade. Shade, therefore, has an important function in the prevention of soil erosion other than its main one of preventing the direct beating of rain on the soil. It renders the soil more absorptive by improving its physical structure ; the fact that a moist soil absorbs water more readily than a very dry one is not generally appreciated. The leaf-fall and loppings are an additional asset which shade trees provide, and it is recommended that they be incorporated in the soil rather than left to form a mulch on the surface. The advantages of incorporation are that the soil texture is improved and that fertility is increased if burying is done early. The improvement of texture leads to an increase of absorptive power and therefore to a diminution of surface run-off. Under natural conditions processes which result both in the formation and in the breaking-down of organic matter go on in the soil. According to the soil temperature the building-up process may proceed more rapidly than the breaking-down process, or *vice versa*. At low soil temperatures (those below 78° Farenheit) there is normally an accumulation of organic matter in the soil, but at high soil temperatures a reduction of the organic matter content of the soil takes place. The nitrogen content of soils is closely related to their organic matter content and it therefore follows that the nitrogen and organic matter content of soils increases as the soil temperature is reduced. The main source of the heat which causes increases in the temperature of the soil in Ceylon is radiation from the sun. Thus, the provision of shade to the soil, whether it be in the form or high shade or of low shade such as ground cover crops, has a marked effect in improving soil texture and soil fertility, and so in reducing soil erosion. Some indication of the degree to which soils with a high organic matter content can absorb and retain water may be appreciated when the following facts are considered. One hundred pounds of dry sand can hold $2\frac{1}{2}$ gallons

of water, the same quantity of dry clay can hold 5 gallons of water, while the same quantity of dry humus can hold 19 gallons of water. The incorporation of organic matter with the soil is thus a positive move in the direction of prevention and control of soil erosion. Surface mulching, by itself, is a neutral step which does not take full advantage of the material at hand. Eroded soil contains particles of various sizes and the greater part of this soil material consists of clay particles which are the most minute in size. These are the most important constituents of all soils as they provide the available nutrients for the plants. In cases where any erosion does take place it is extremely desirable that this very valuable part of the soil should not be lost to crop growth. Owing to the minute size of these eroded particles they are readily disturbed by the beating action of rain on the soil surface, and are easily transported and held in suspension by water. Evidence of this is to be seen in the muddy colour of many of the main streams and almost all the rivers of the Island; the fine clay particles being held in suspension by the water impart to it the characteristic colours which these streams and rivers possess. These minute clay particles, when once in suspension, settle or are deposited only very slowly even in still water. It is possible, however, both in the soil and in water, to cause them to coalesce and adhere together to form compound aggregates of a larger size, humus being one of the commonest naturally occuring substances which can cause the aggregation or flocculation of these minute soil particles. When in a flocculated state, the soil particles are taken into suspension by water less readily; and from suspension are more rapidly deposited. This flocculating action is therefore another extremely important way in which humus or soil organic matter acts in the reduction of soil erosion. The valuable soil particles carried in suspension in the surplus run-off should be trapped, and returned to the site of their removal. In order to do this it is necessary to collect, trap, and bring to a state of immobility the run-off water so that the soil particles suspended in it may have a chance of settling. The collection and trapping of this surplus water is effected by means of the various types of silt pits, contour trenches and platforms already described. Their size and frequency will depend upon the quantity of water that has to be held up, which again will depend upon local factors such as the amount and intensity of the rainfall, the efficiency of any existing soil cover and the absorptive

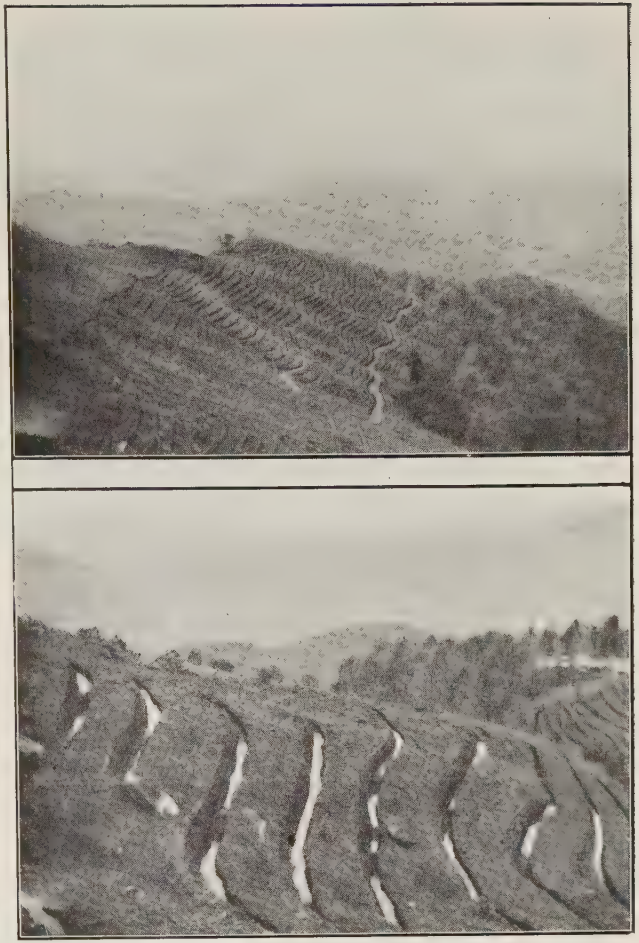

Fig. 11. Mr. Du Prè Moore's contour trenches after a heavy shower

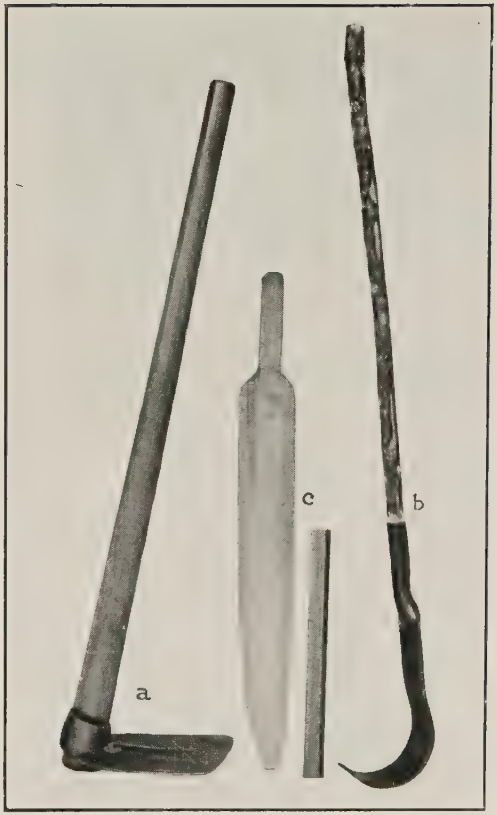

Fig. 12. Weeding tools used in Ceylon (a foot-rule is included for comparison)
a—Mamoty, *b*—Karandi, *c*—Wooden Spear

capacity of the soil. Drains should not be considered a necessity unless the quantity of surplus run-off water is greater than can be dealt with economically by silt pits, contour trenches, etc., and, when necessary, they should be designed so that they provide the maximum opportunity for the deposition of suspended soil particles. This can be effected by reducing their gradient to the minimum and by the construction in them of the necessary steps, locks, spills and water cushions.

The fertility value of the eroded and transported soil particles is considered to be sufficiently great to render their return to the area under cultivation extremely desirable. The accumulations in silt pits, contour trenches, drains, etc., render this easily possible after the water that was in them has been disseminated through percolation, absorption, etc.

The regular return of this soil to the cultivated area will enable these silt traps to be maintained in an effective condition. The location or siting of them in the necessary places will reduce the distance this eroded soil has to be transported back and thus save a considerable amount of labour and expense.

The loss of the most valuable part of the soil through erosion has a cumulative effect of incalculable consequence if regarded in its proper perspective. If permitted to continue in the future to the same degree as in the past, it will create problems of sufficient magnitude to cause an economic crisis. These problems in the main are twofold ; loss of soil fertility and flood damage. Economic agricultural production depends upon the maintenance of soil fertility. The regular loss of the most valuable fraction of the soil, at a rate which is considerably greater than that of the natural reproduction of this fertility, must have far reaching effects. It will reduce the soil of all the unprotected elevated portions of the Island which are under cultivation to such a state of infertility that in the course of time their cultivation will be uneconomic. The deposition of the eroded soil in the lower lying parts of the Island increase the liability of these areas to floods ; and the damage which such floods cause is augmented, thus imposing more frequent or heavier calls upon a diminishing general revenue. The financial prosperity of Ceylon is dependent upon the prosperity of its agricultural production, which is dependent upon the fertility of its soil. The soil of Ceylon is thus the natural capital of the Island, and of such vital importance that every effort should be made to preserve it.

THE PRESENT POSITION OF THE TRADE IN CEYLON CITRONELLA OIL

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THE question of improving the citronella oil industry in Ceylon has recently been receiving the serious attention of the Agricultural Department. Of the two aspects of the problem, that of improving the quality and yield of oil by selection and cultivation is being proceeded with. The other, the marketing aspect, is to a large degree governed by the requirements of the trade. With the object of ascertaining what these requirements are so that a suitable programme of production research based thereon could be planned, the views of some of the leading exporters and dealers in the commodity locally were obtained. These opinions are embodied in the paragraphs that follow.

Ceylon citronella oil is sold in two grades: 'ordinary' or f.a.q. (fair average quality) oil in which the bulk of the business is done (over 95 per cent. it is estimated), and 'estate' oil which is of superior quality.

The former is almost invariably sold on the basis of a solubility test of the oil in alcohol, known as the Schimmel's test. This test permits of the addition of petroleum products up to a limit of about 7 per cent. Buyers abroad are aware that Ceylon f.a.q. citronella oils are not pure oils, but generally adulterated with petroleum products. They are, however, prepared to purchase any quantities of these oils as long as they pass the Schimmel's test. These oils are much in demand by the soap-making, cosmetic and cheap perfumery industries. In the opinion of all exporters and dealers of the commodity, the trade does not require pure oil and will not generally pay more for it than for ordinary f.a.q. oil. Adulteration, though a bad practice, has therefore according to a large producer

" no special significance to-day, as the industry has adjusted itself to this organised system of adulteration."

Exporters all agree that the present low market price of Ceylon citronella oils is not due to adulteration. Five years ago oil of identical quality realised three times as much. The quality of the oil shipped to-day is considered generally superior to that shipped 25 years ago. The question of price is a matter of supply and demand and the present low price of both Ceylon and Java oil is entirely due to overproduction in Java. This is clearly seen from the export figures. Thus while Java exported 815 tons and Ceylon 543 tons of oil in 1930, in 1934 Java exported as much as 1,778 tons and Ceylon 687 tons.

Estate quality oil is unadulterated oil and is generally sold on the basis of its total acetylisable content estimated as geraniol, with a minimum of 60 per cent. " geraniol." The demand for this oil is very small and several attempts made to popularise it have not met with any response on the part of the buyers. The premium paid for such oils is also small, being 2 or 3 cents more per lb. than for ordinary f.a.q. oils. Samples of estate oils sent by two exporting firms to two of the principal buyers of citronella oil abroad, were reported on as follows : " This is quite a nice oil, but we wouldn't pay more for it than for the ordinary f.a.q. oil," and " Very good oil, strong and exceptionally sweet odour ; are not prepared to pay more than for supplies of usual quality." It will thus be seen that the export of pure Ceylon citronella oils does not appear to offer any advantages to the Ceylon industry.

Ceylon oil is distilled from two varieties of citronella grass (*Cymbopogon nardus*) : the *lena battu* and the *maha pangiri* which is a Java type. On Ceylon plantations the grasses are invariably mixed, but the former predominates. Pure *lena battu* oil has a " geraniol " content of 55-60 per cent. and *Java* oil an average of about 85 per cent. Java oil naturally fetches a better price on the world's markets, but the differences are not always commensurate with the respective qualities of the oils as gauged by their geraniol contents. Most exporters consider that it would be unwise to abandon the production of

lena battu oil in favour of the Java type, for the following reasons :—

(1) The oils are used for different purposes : the Java oil for high grade scents and the Ceylon oil for soaps and cheap perfumery. There is accordingly a ready market for Ceylon f.a.q. oils.

(2) If Ceylon exported oil of the Java quality, the severe competition that must ensue might result in a general decline of prices of oil of this quality, and a rise in price of Ceylon quality oil.

(3) It is by no means certain that *maha pangiri* grass planted in Ceylon will give the same results as in Java with its rich volcanic soil. In actual practice it has been found that this grass requires a good deal more attention and more frequent replanting than *lena battu*. It also lends itself to less frequent cutting and needs a more fertile soil than *lena battu* which grows on soils of the poorer type, constituting 70 to 80 per cent. of the citronella-growing area.

The main line of work suggested is the improvement of the yield and quality of *lena battu* oil by selection, cultivation and manuring.

In regard to the tests for citronella oil, it is generally admitted that the Schimmel's test is by no means a suitable test for gauging either the purity or the quality of the oils. Occasionally pure oils fail to pass the test. [1] It is, however, a rough and ready test for detecting gross adulteration of the oil with petroleum, and is thus considered suitable for the trade in f.a.q. oils. Adulteration with kerosene can be determined with reasonable accuracy by the " Raised Schimmel's test." The sale of local citronella oil on the " geraniol " basis is not considered practicable for a number of reasons. For one it is unnecessary with f.a.q. oils which form by far the greater proportion of the Ceylon oils exported ; for another it would increase the price of the oil to the buyer and eventually react on the producer. Market oils, when required, are however sold on their "geraniol" contents.

To sum up the present trade position :

The bulk of the business in Ceylon citronella oil is done in what is known in the trade as f.a.q. oil. This oil is not necessarily a pure oil, but may be adulterated with petroleum products up to a point. It must, however, pass the Schimmel's test. Adulteration therefore, within reasonable limits, is permissible. There is a ready demand for this oil, which has very definite uses. Buyers are not generally prepared to pay more for pure oils (market oils), the demand for which is therefore very limited. The present low price of citronella oil is not due to adulteration but to over-production in Java, and the difference between that of Java and Ceylon oil is normal. As Ceylon f.a.q. oil is well known to and accepted by the trade it would, it is considered, be a mistake to force any change on the trade not asked for by it. The compulsory sale of oils on geraniol basis is considered impracticable and unnecessary so far as present trade requirements go. The improvement by selection, cultivation and manuring of the yield and quality of the *lena battu* oil, the typical Ceylon oil, is considered to offer greater possibilities than the production of oil of the Java type (*maha pangiri*). One exporter considers that the local price of citronella oil would improve if a preferential duty were allowed on Ceylon oils imported into the United Kingdom.

REFERENCE

1. Joachim, A. W. R.—Chemical Notes (6). Ceylon Citronella Oil Investigations. *The Tropical Agriculturist*, Vol. LXXIII, September, 1929.

TERMITE INVESTIGATIONS

This work is now divided between the Tea Research Institute and the Department of Agriculture in accordance with the following tentative arrangement :— The Institute's Entomologist now deals with all enquiries and investigations relating to termites attacking tea, green manure and shade trees interplanted with tea and termites and other insects infesting buildings on estates where only tea is grown. The Department's Entomologist is responsible for advisory and other work relating to termites affecting other crops and to those attacking all buildings other than those mentioned above.

AN AMENDED NOMENCLATURE OF SOME IMPORTANT ECONOMIC PLANTS GROWN IN CEYLON

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A. I. C. T. A. (Trinidad)

IN recent years the critical examination of plants has resulted in many alterations to botanical names. Unless the latest accepted nomenclature is known the perusal of present day scientific literature is liable to be confusing.

The list has been prepared for the guidance of those interested. Familiar synonyms, popular names and, wherever possible, local vernacular names have been indicated.

To avoid confusion, it is desirable when labelling plants or when any reference is made to plants by their latest accepted names to indicate, within brackets, the familiar synonyms, etc.

1. *Aberia Gardneri* Clos.
   (*Dovyalis hebecarpa* Warb.)
   Ketambilla (S). Ceylon Gooseberry.

2. *Achras zapota* Linn.
   (*Achras sapota* Linn.)
   Sapodilla.

3. *Aleurites moluccana* (Linn.) Willd.
   (*A. triloba* Forst.)
   Rata-kekuna, Tel-kekuna (S). Candle nut.

4. *Ananas comosus* (Linn.) Merr.
   (*A. sativus* Schult. f.)
   Annasi (S). Pine-apple.

5. *Annona* Linn.
   (*Anona* Linn.)

This alteration applies to all species, including the following :—

A. cherimolia Mill. Cherimoyer.
A. glabra Linn. Alligator pear.
A. muricata Linn. *Katu-anoda* (S). *Sitha* (T). Soursop.
A. reticulata Linn. *Anoda* (S). *Ramsitha* (T). Bullock's heart, custard apple.
A. squamosa Linn. Sugar apple.

6. *Artocarpus communis* Forst.
(*A. incisus* Linn. f. *A. incisa* Linn. f.)
Del (S). Breadfruit.

7. *Artocarpus integer* (Thumb.) Merr.
(*A. integrifolius* Linn. f. *A. integrifolia* Linn. f. *A. integra* Merr.)
Kos (S). Jak.

8. *Bambusa multiplex* Raeusch.
(*B. nana* Roxb.)
Dwarf or Chinese bamboo.

9. *Benincasa hispida* Cogn.
(*B. cerifera* Savi.)
Alupuhul (S). *Puchini* (T). Ash pumpkin.

10. *Bombax malabaricum* DC.
(*Gossampinus malabarica* DC.)
Katu imbul (S). Silk or red cotton tree.

11. *Cajanus cajan* (Linn.) Millsp.
(*C. inodorus* Medic. *C. indicus* Spreng.)
Rata-thora (S). *Thavarai* (T). Dhal. Pigeon pea.

12. *Camellia sinensis* (Linn.) Kuntze.
(*Thea sinensis* Linn.)
Tea.

13. *Canangium odoratum* King.
(*Cananga odorata* Hk. f. and Th.)
Wana-sapu (S). Ylang Ylang.

14. *Canna edulis* Ker-Gawl.
But-sarana (S). Edible canna.

15. *Ceiba pentandra* Gaertn.
(*Eriodendron anfractuosum* DC.).
Imbul, Pulun-Imbul (S). Kapok. Silk cotton.

16. *Citrus paradisi* Mac. f.
(*C. maxima* var. *uvacarpa* Merr. and Lee.)
Grape fruit.

17. *Coleus parviflorus* Benth.
(*C. tuberosus* Benth.)
Innala (S). Country potato.

18. *Delonix regia* Rafin.
(*Poinciana regia* Boj. ex Hook.)
Flamboyante.

19. *Dolichos biflorus* Linn.
(*D. uniflorus* Lam.)
Kollu (S). Horse gram.

20. *Dolichos hosei* Craib.
(*Vigna oligosperma* Baker.)

21. *Duranta repens* Linn.
(*D. plumieri* Jacq.).

22. *Eugenia aromatica* (Linn.) Baill.
(*E. caryophyllata* Thumb.)
Karabu (S). *Karambu* (T). Cloves.

23. *Eugenia brasiliensis* Lam.
(*E. Michelii* Lam. E. *uniflora* Linn.)
Brazil cherry.

24. *Eugenia cumini* (Linn.) Merr.
(*E. jambolana* Lam.)
Maha dan, Madan (S). *Naval, Peru naval* (T).

25. *Feronia limonia* (Linn.) Swingle.
(*F. elephantum* Correa, *Limonia acidissima* Linn.)
Diwul (S). *Vila, Vilatti, Magaladikkuruntu* (T).
Elephant apple. Wood apple.

26. *Flacourtia indica* (Burm. f.) Merr.
(*F. ramontchi* L'Hérit.)
Uguressa (S). *Katukali, Karumurukki* (T).

27. *Gliricidia sepium* (Jacq.) Steud.
(*G. maculata*, H.B.K.).

Note.—The colours of the flowers vary; sometimes they are striped or blotched, in which case they are referred to the form *maculata* Urb.

28. *Glycine max* (Linn.) Merr.
(*G. soya* Sieb. and Zucc., *Soya hispida* Maxim.)
Soybean. Soya.

29. *Litchi chinensis* Sonner.
(*Nephelium litchi* Camb.)
Litchi.

30. *Luffa cylindrica* (Lour.) Roem.
(*L. aegyptiaca* Mill.)
Niyan-weta-kolu (S). *Pikku, Pichukku* (T). Loofah.

31. *Madhuca longifolia* (Linn.) McBride.
(*Bassia longifolia* Linn.)
Mee (S). *Iluppai* (T).

32. *Moringa oleifera* Lam.
(*M. pterygosperma* Gaertn.)
Murunga (S). Drumstick tree. Horse radish tree.

33. *Nelumbium nuciferum* Gaertn.
(*N. speciosum* Willd.)
Nellun (S). *Tamarai* (T). Sacred bean. Lotus.

34. *Nymphaea nouchali*, Burm. f.
(*N. Lotus* Linn.)
Olu, Et-olu (S). Water lily. Egyptian lotus.

35. *Ocimum canum* Sims.
(*O. americanum* Linn. *O. album* Roxb.)
Hin-tala (S). *Kanchan-Korai* (T).

36. *Paspalum urvillei* Steud.
(*P. larranagai* Arechav.).

37. *Persea americana* Mill.
(*P. gratissima* Gaertn.)
Etpera (S). *Anakoya* (T). Avocado. Alligator pear.

38. *Phaseolus aureus* Roxb.
(*P. radiatus* Linn. *P. max.* Linn.) plant erect.
Mun, Muneta (S). *Chruppayaru* (T). Green gram. Mung bean.

39. *Phaseolus mungo* Linn.
(*Phaseolus max.* Linn.) plant procumbent or twining.
Ulundu (S). *Ulunthu* (T). Black gram.

40. *Pithecellobium saman* Benth.
(*Pithecolobium saman* Benth. *Enterolobium saman* Prain.)
Penikaral, Peni-mora (S). *Inga* (T). Rain tree.

41. *Sesamum orientale* Linn.
(*S. indicum* Linn.)
Tel-tala (S). *Ella* (T). Gingelly.

42. *Spondias prunata* (Linn. f.) Kurz.
(*S. magnifera* Willd.)
Embarella (S). *Ampallai* (T). Hog plum.

43. *Trachyspermum ammi* (Linn.) Sprague.
(*Carum copticum*, C. B. Clarke)
Ajawan Asambadam (T).

44. *Trachyspermum roxburghiamum* D.C. Sprague.
(*Carum roxburghianum*, C. B. Clarke)

45. *Vetiveria zizanoides* Nash.
(*Andropogon muricatus* Retz. *A. squarrosus* Linn. f.)
Sewandara (S). *Vetiver* (T). Khas-Khas.

46. *Vigna unguiculata* (Linn.) Walp.
(*V. sinensis* Engl.)
Me-karal (S). Cowpea.

SELECTED ARTICLES

BUNCHY TOP DISEASE OF BANANAS*

THE bunchy top epiphytotic in banana plantations in New South Wales during the period 1922-1927 furnishes the most spectacular instance of intense economic stress yet caused by a plant disease in Australia. Although banana culture at this time did not constitute an extensive industry, it had expanded rapidly as a post-war closer settlement development and was the sole means of livelihood of approximately one thousand families in New South Wales, as well as supporting important subsidiary industries. It was also a highly capitalised industry in which the Repatriation Department had invested generously, and which land salesmen had "boomed" so much that bearing plantations realised as much as £300 per acre and virgin boulder-strewn slopes changed hands at £150 per acre as plantation sites. Such capital outlays may have been justified had not bunchy top intervened, since with the ruling high prices for banana fruit good incomes were made and the towns of Tweed Heads, Murwillumbah and Mullumbimby went through a period of prosperity of the gold-rush type.

The bunchy top disease made its appearance in plantations during the early stages of development of the industry, in all probability being introduced in 1913 by the planting of infected banana suckers imported from Fiji. By 1922 there were approximately 5,500 acres planted to bananas in New South Wales and bunchy top was then regarded as a serious menace to the industry. Unsuccessful attempts were made by the New South Wales Government to check the spread of the disease by the establishment of "buffer" zones between affected and unaffected areas, but by 1925 the area under bananas had dwindled to 1,500 acres and production had decreased from 433,000 tropical (1·5 bushels) cases in 1922 to 60,000 tropical cases in 1925. Fully 90 per cent. of the land in banana culture in 1922 ceased production and owing both to its highly capitalised condition and specialised nature, being mainly hilly, stony land, there was no other crop which would replace bananas, at least, on the same lucrative basis. Many individuals who had invested in banana growing were faced with financial ruin and much unemployment prevailed among plantation workers and those engaged in the subsidiary industries of haulage, case-making, etc. The Government lost heavily on account of failure of

*By C. J. Magee, M.Sc., B.Sc., Agric. Plant Pathologist, Department of Agriculture Sydney, in *The Journal of the Australian Institute of Agricultural Science*, Vol. 2, No. 1,, March, 1936

Soldiers' Settlement schemes in the affected areas and fall of rail freight, income taxes, etc.

In 1924-25 an investigation of the disease as a co-operative project of the Governments of the Commonwealth, New South Wales and Queensland, demonstrated that bunchy top was a virus disease which was disseminated by the planting of infected suckers, and that the banana aphid, *Pentalonia nigronervosa,* was the chief and possibly only insect vector. Examination of the contributory factors to the epiphytotic indicated that while this insect was an important agent in natural transmission of the disease, the part it had played in the downfall of the industry was equalled in importance by the existence of large numbers of centres of infection which had been established by planting of infected suckers over wide areas. This, together with observations that the bunchy top virus had a narrow host range while the vector had limited feeding habits, and that the situation was not complicated by the existence of wild hosts in the affected territory, made possible the formulation of control measures for district application. These involved registration of plantations, eradication of diseased plants and controlled replanting with known disease-free stock.

It was thought that a scheme of this type would collapse if left entirely to the goodwill of the planters, and in 1927 proclamations and regulations were gazetted under the New South Wales Plant Diseases Act 1924, proclaiming quarantine areas and governing movement of suckers from one district to another, permits to plant, and procedure in connection with the eradication of diseased plants. Since November, 1927, the banana industry in New South Wales has been under Government control, but this control has been mainly one of guidance rather than policing, and the success which has attended efforts to rehabilitate the industry must be attributed as much to the co-operation of planters and their organisations as to any other influence. Use has certainly been made of the law courts in enforcing the control regulations but the number of prosecutions has been comparatively small.

Eradication of diseased plants appeared to be the most difficult problem in the control programme but since many plantations, being totally infected were worthless and as stock had over-run and eaten down many others, this portion of the scheme was carried out with less trouble than was anticipated. It is noteworthy that the New South Wales Government was not called upon to provide funds directly for eradication. The division of the affected areas into "zones," which to some extent demarcated badly affected districts from lightly affected ones, allowed discrimination in administration of the regulations and enabled eradication and replanting to proceed with a minimum of friction.

In 1927, representative banana growers in the various districts were elected to committees under the title of zonal committees to assist the

Department of Agriculture in the application of the regulations and in February, 1928, four full-time inspectors were appointed as officers of the Department to supervise eradication and the issue of permits for restocking. At a later date the duties of the zonal committees were absorbed by the various branches of the Banana Growers' Federation, and as the industry grew additional Government inspectors were appointed.

The control campaign early showed signs of being successful and gave encouragement for its continuance. Suckers for restocking in the first instance came mainly from known disease-free areas in Queensland and later from disease-free zones in New South Wales. Bunchy top did not appear for some years in most of the control-planted plantations. During the first two years of reconstruction of the industry the area planted was not extensive, which is attributable to the hesitancy of growers to invest money in banana growing while the memory of the ravages of bunchy top was still fresh. This was perhaps fortunate for the control scheme as it gave time for more complete eradication before the heavy planting period arrived. The accompanying table, compiled by Mr. H. W. Eastwood, Senior Fruit Instructor and Officer-in-Charge of eradication and replanting, indicates the rate of expansion of banana growing from 1928 onwards.

Table showing Banana Acreage and Production in New South Wales, 1928-35.

Year	*Acres*	*Production (Tropical Cases)*
1928	1,992	74,703
1929	3,340	81,455
1930	4,959	117,120
1931	6,256	216,756
1932	7,443	468,376
1933	12,846	498,694
1934	22,287	875,867
1935	20,133	1,208,839

Until 1932 the growth of the industry was gradual and very little bunchy top was to be found in the newly established plantations. A new difficulty presented itself, however, just when both growers and the Government were feeling proud of the accomplishment of rebuilding a ruined industry. High prices for banana fruit prevailed during the winter of 1932 and a " banana boom " commenced, resulting in the planting of another 9,643 acres in the spring of 1933. Such rapid extension of the area under bananas was viewed with alarm by the Government as it was obvious that overproduction of fruit must result and that attendant low returns would make many plantations unpayable. The Government had no statutory powers to prevent the planting of healthy bananas and could only issue warnings of the dangers involved. It was feared that the bunchy top control scheme would be

seriously challenged by unremunerative returns to growers ; in fact in 1934, when the depression in prices of banana fruit commenced, plantation labour was greatly curtailed and there was noticeable a marked increase in neglect of detection and eradication of diseased plants.

Even before this period of overproduction, in 1933, a slight increase in the prevalence of bunchy top was apparent. Success in maintaining plantations free from the disease in the past made some growers indifferent to the dangers of bunchy top, and this together with the fact that plantations established in 1928 and 1929 were now becoming less productive, led to considerable neglect in promptly dealing with diseased plants. There were no serious outbreaks, however, until 1935 when low prices had been operating for some time and many plantations had become as much a liability as an asset. Bunchy top again called for special action and increased vigilance on the part of the inspectors. Such outbreaks have not so far imperilled the industry but they have served as a warning that bunchy top must still be reckoned with and that the fullest co-operation is necessary in combatting it.

The bunchy top control campaign provides an interesting demonstration of field control of a virus disease and may be noted also as an instance of successful application of legislation in plant disease control. Virus diseases rank amongst the most important maladies affecting crop plants and are also perhaps the most troublesome to combat. The problems they create are intensified by their insect vector phases which appear to offer insuperable barriers to solution. In general, the method of attacking virus diseases is simple but laborious, depending primarily on the prompt detection and removal of diseased plants to reduce sources of infection. In very few instances only can use be made of resistant varieties. The application of control measures on a district scale, as has been done with bunchy top, is unusual and would be practicable in the case of very few virus diseases. The narrow host range of bunchy top and absence of wild hosts are the factors mainly responsible for the success which has been achieved. Localisation of the banana industry in New South Wales to limited territory has, however, also been important since it has assisted growers in becoming well organised and has fostered co-operation with the Government.

A NEW DISEASE OF THE DAHLIA*

(*Note.*—The following article was written when the disease of dahlias caused by *Entyloma dahliae* was first recorded in England, in 1928. Specimens of the disease have been recently received from a bungalow garden in Kotmale and the article is now reproduced in order to warn growers of dahlias that the disease is present in Ceylon. Prompt action on the lines suggested below will prevent the disease from gaining a firm foothold in the Island and will help to keep out a troublesome and unsightly disease.

The illustration in the original paper could not be reproduced satisfactorily and the plate illustrating the article is from a photograph of diseased leaflets obtained locally.—M.P.)

IF one consults the relevant foreign plant disease literature it will be found that the Dahlia is subject abroad to attack by a considerable number of fungi and by some bacteria. In our own phytopathological books and papers, however, this plant, as a host for fungus attack, is conspicuous by its absence, and complaints are rarely received. Sclerotinia Sclerotiorum, (Lib.) de Bary, has however, been recorded as destroying Dahlia roots in storage in this country, just as it destroys Jerusalem Artichokes, Carrots, etc., but even this disease is not very common.

Our growers of Dahlias, therefore, will regret to learn that their former freedom from fungous diseases is now threatened by the recent appearance in our midst of a new disease which promises, if allowed to run unchecked, to cause considerable trouble. It takes the form of a leaf-spot, which usually becomes pronounced on the older leaves (including the stalks) when the season of growth is fairly well advanced, and when the plants are beginning to flower.

The spots are evident on both sides of the leaves. They are rounded in outline, except where they abut against a substantial vein, and have a well-defined margin. They vary from about one-sixteenth to one-quarter-of-an-inch in diameter, and when numerous they coalesce, forming rather large, irregular blotches in which, however, the original individual spots may still be recognised. At first the spots are pale green or yellowish in colour ; as they get older and enlarge, the centre of each spot becomes grey or brownish-grey, owing to the death of the tissue : and at this stage the spots show the

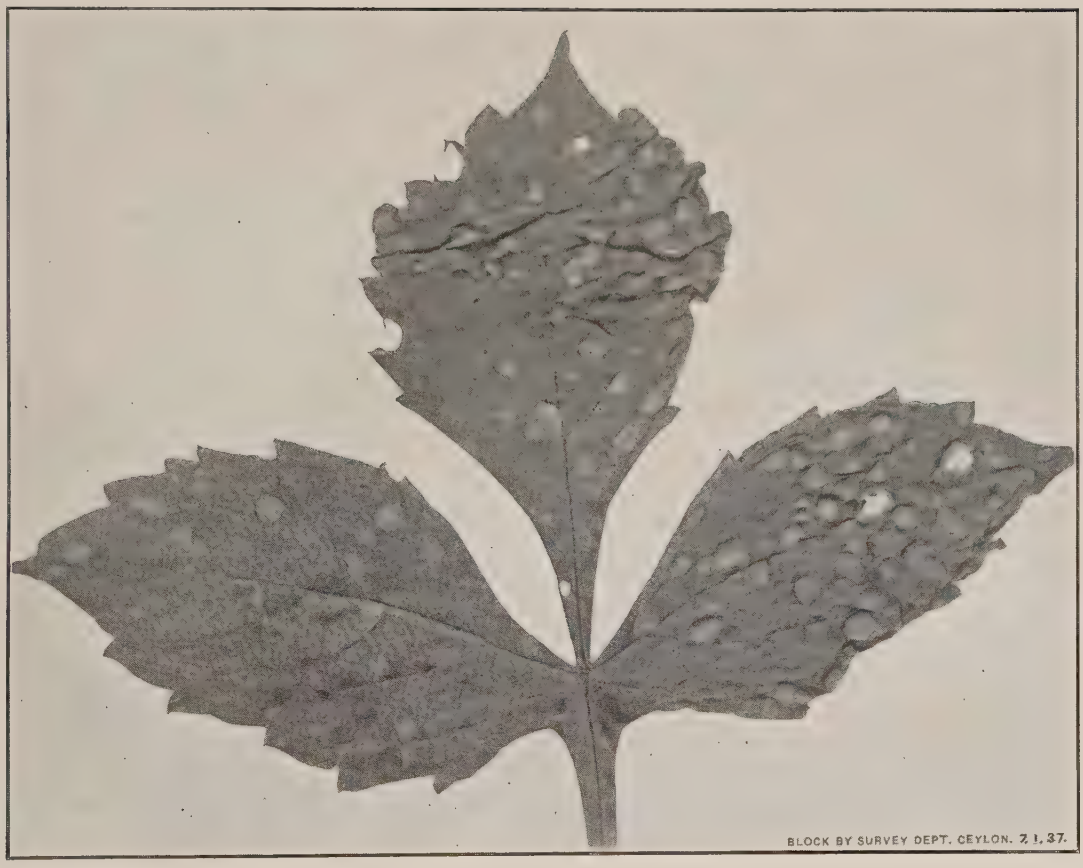
*By Geo. H. Pethybridge, in *The Gardeners' Chronicle*, Series III, Vol. LXXXIV, p. 393, November, 1928

central dead tissue surrounded by a sort of halo, well seen if the affected leaf be viewed by transmitted light. Finally, the spots turn wholly brown, or greyish-brown, and have a darker brown line running round the margin. In leaves that have yellowed, the spots are very conspicuous, the more so since they are sometimes surrounded by, or situated near, a certain amount of tissue that still retains its green colour. No mould growths or fungus fructifications are readily visible on either the upper or lower surfaces of the spots ; and the central dead tissue becomes quite brittle when dry and often falls out partially or completely, thus giving the leaf a shot-hole appearance.

The various shades of greens and browns exhibited by leaves attacked in such a fashion are notoriously difficult to represent by photography, but the accompanying illustration is an attempt to show the state of affairs produced by this disease in a case of rather advanced and severe attack. It will be clear that not only is the appearance of the plants rendered very unsightly, but the loss of green food-manufacturing tissue is bound to act adversely on the vigour of the plants in the long run.

The fungus that causes the disease is one of the smuts and has been named *Entyloma dahliae* by Sydow. True, the symptoms produced are not at all like those one is accustomed to associate with smut attack, such as malformations and the production of masses of black, soot-like powder in some part of the host, *e.g.*, the smuts of Cereals, or those of the Onion, Gladiolus, Anemone and Violet. Nevertheless, in its mode of life and reproduction, *Entyloma dahliae* closely resemble other smut fungi, and several members of the genus are responsible for the production of spots on the leaves of various plants, notably Lesser Celandine, Poppy, Golden Saxifrage, Forget-me-not, Scentless Mayweed and Marigold.

Microscopical examination of the affected tissue of the Dahlia leaf discloses the presence of numerous light brown, smooth, thick-walled, approximately spherical spores, that have been derived from a sparse, somewhat evanescent mycelium or spawn. These spores arise and remain between the cells and on germination, each produces a tubular outgrowth which proceeds to the surface of the leaf. Having arrived there, the tip of the tube projects slightly through a stoma (or breathing-pore) and develops a crown, or rosette, of mycelial segments from which secondary spores, or sporidia, are produced in considerable numbers. These sporidia may conjugate, and secondary sporidia are produced from them. It is by the distribution of these sporidia and secondary sporidia—they are easily wafted away or splashed by the rain to other parts of the same leaf, or to other leaves—that the disease is spread during the season. Damp weather and a shady position are favourable to the disease, which, under such conditions, may reach almost epidemic proportions. The spores lying within the tissue of the spots may germinate as soon as they are ripe, but many of them remain as resting spores after the leaf has died, and they germinate the following season. Dead, affected leaves



A New Disease of the Dahlia

should therefore be looked upon as the source from which the disease reappears each season. Cactus Dahlias are said to be more susceptible to attack than Pompons ; and, while no varieties derived from Dahlia variabilis are known to be absolutely immune, yet those derived from D. Merckii have apparently remained free from the disease.

Entyloma dahliae was first found by Pole Evans, in Natal, in 1911, on D. variabilis, and it was described and named by H. and P. Sydow in 1912. Its presence in Europe was first detected by Sternon, in Belgium, in 1918. It was noted in Holland in 1920, in France in 1922 or 1923, in Germany in 1924, and Czechoslovakia in 1926. It appears to have been seen in England at least a year ago, for, according to information received, it was sent to Mr. J. Ramsbottom from Worplesdon in 1927 ; but up to now its presence does not appear to have been recorded by publication.

The first specimens of the disease that the present writer had the opportunity of inspecting were received at the Ministry of Agriculture's Plant Pathological Laboratory in August last from Mr. J. Rees, Adviser in Agricultural Botany, University College, Cardiff ; and they were obtained from the Duffryn Gardens, St. Nicholas, Glamorganshire. It was stated that the disease had been present there for the past two or three years, and appeared to be causing considerable damage. A second case was reported in September last by Mr. W. Buddin, adviser in Mycology at the University of Reading, who had diagnosed it on plants submitted to him by Mr. A. J. Cobb, University Lecturer in Horticulture, from Shinfield, near Reading. Doubtless it exists in other centres and, attention having once been aroused, the disease will probably be recognised in them and dealt with.

The object of the present note, indeed, is to direct attention to this new disease, so that it may be dealt with so promptly as possible, if and when it puts in an appearance. The situation at present cannot be described as alarming, but it would certainly appear that the disease is capable of causing much trouble, and if it can be "nipped in the bud," so much the better. The method of controlling it is the old-fashioned and often despised one of collecting and destroying (preferably by fire) all the spotted leaves, including any that may remain attached to the plants when lifted for winter storage, since they contain the resting spores of the fungus. Those who do not apply this simple rule of garden hygiene in their work must not be surprised if the disease, like others, gets out of hand with them.

No exact experimental attempt to combat the disease directly by spraying appear to have been made, but, in Germany, spraying with Bordeaux mixture, or with lime-sulphur solution, has been recommended. Such spraying should be carried out at intervals during spring and early summer, and preferably after removal and destruction of any spotted leaves that may be present. Liming and digging the soil deeply have also been recommended, while Dahlias should be planted so early as is feasible and safe in an open, airy situation,

avoiding over-crowding, and in a position so far removed as possible from one in which the *Entyloma* disease may have appeared during the previous season.

(*Note.*—Since the above article was written, workers in England have shown that the disease can be controlled by spraying with a standard fungicide, such as Bordeaux mixture or lime-sulphur. In Ceylon, where the seasonal variation of temperature is not so marked as in temperate climates, spraying would be necessary throughout the year, if the disease were once established and if the growers wished to keep it completely controlled. Growers of dahlias, therefore, are warned to keep a sharp look-out for the disease and, should it appear, are requested to inform the Mycologist, Department of Agriculture, Peradeniya, who will be pleased to assist them to stamp out the disease before it becomes too widespread to be eradicated easily.—M.P.).

CORRESPONDENCE

Teldeniya,
29th January, 1937.

The Editor,
Tropical Agriculturist,
Peradeniya.

Dear Sir,

We now hear a great deal about Roselle. Can you please give some notes on its cultivation ? What are the districts most suited to extensive cultivation of Roselle ?

Thanking you,

Yours faithfully,
U. B. Ellepola.

NOTE BY EDITOR

Supplies of this product from established sources have brought the market to saturation point and in the circumstances the Research Committee of the Agricultural Department has advised the Director not to proceed with experiments with the production of this article.

COCONUT RESEARCH SCHEME

BOARD OF MANAGEMENT

Minutes of the thirty-fifth meeting of the Board of Management held (by courtesy of Mr. C. H. Collins, C.C.S.) in the office of the Deputy Financial Secretary, New Secretariat, Colombo, on Thursday, December 10, 1936.

Present.—Mr. E. Rodrigo, Acting Director of Agriculture, in the Chair. Messrs. C. H. Collins, C.C.S., Treasury Representative, O. B. M. Cheyne, A. R. Ekanayake, D. D. Karunaratne, J.P., Wace de Niese, H. M. Peries, G. Panditteseker, J.P., U.P.M., Gate Mudaliyar A. E. Rajapakse, O.B.E., M.S.C., Dr. R. Child, Director of Research, acted as Secretary.

MINUTES

The minutes of the previous meeting held on October 2, 1936, which had been circulated to Board Members were confirmed.

STAFF

(*a*) *Technical Assistant to Technological Chemist.*—The Board unanimously accepted the recommendation of the Director of Research that Mr. Mylvaganam, B.Sc., be appointed to the vacant post of Technical Assistant to the Technological Chemist.

(*b*) *New Field Assistant.*—It was agreed to advertise this vacancy at once.

FINANCE

The statement of Receipts and Payments for the quarter ended September 30, 1936, was approved.

BUILDING SUB-COMMITTEE

The minutes of the three meetings held by this Sub-Committee on November 6, 20 and 30 had been circulated to all members of the Board of Management. These minutes included all of the Sub-Committee's recommendations.

New Building for Battery Room and Store.—It was decided to accept the Sub-Committee's recommendation that a building be erected to include a battery room, two large stores and an office for the Estate Superintendent and a Supplementary Estimate under Capital Expenditure A was sanctioned for 1937.

It was decided that tenders should be called for as early as possible. The Chairman was authorised to advertise for tenders as soon as the plan and

specifications were available, and to communicate them to the Board of Management for selection.

Bicycle Shed for Junior Staff.—The Director of Research was authorised to prepare an estimate for this item for consideration at the next meeting of the Board of Management.

Hostel for Staff and Students.—The Board agreed with the Sub-Committee that no action should be taken with this item until any clear necessity arose for its further consideration.

Other items of the Sub-Committee's report were held over.

JUNGLE SUB-COMMITTEE

This committee held a meeting on November 20, 1936, and the minutes of this meeting had been circulated to all members of the Board.

The Chairman said that he thought that, following the Sub-Committee's recommendations, Mr. Samarakkody's suggestion need not be considered further. The Board concurred.

Dr. Child reported that the Geneticist and Soil Chemist had visited another area mentioned in Hettipola, and were of opinion it was not suitable for experimental purposes owing to its distance from Bandirippuwa Estate.

The Chairman said that it seemed necessary therefore to return to the consideration of *Ratmalagara Estate.* It was decided to follow the Sub-Committee's recommendation that an independent valuation should be obtained.

Mr. De Niese was afraid that the establishment of the Scheme's second station also in the Chilaw area might cause some dissatisfaction in the other coconut districts in the Island, particularly in Kurunegala. The Board thought, however, that convenience of administration from Bandirippuwa, in view of the comparatively limited staff and resources of the Scheme, should outweigh other considerations. At the same time the Staff should not overlook Mr. Wace de Niese's point and as much attention as possible should be given to all coconut districts.

ESTATE

The Estate Progress Reports for September, October and November, 1936, were approved by the Board.

PUBLICATIONS OF THE SCHEME

The Chairman said that both he and the Director of Research felt that meetings of the Board of Management had hitherto been too much confined to purely financial and administrative details, and that the Board should be given more opportunity at these meetings to discuss and take a direct part in the experimental policy of the Scheme. The Director of Research, he continued, was of opinion that the technical staff would welcome the interest and co-operation of the Board in their work, and he himself thought that it

would be desirable for every major experiment to be approved by the Board before its initiation and reported on from time to time. As a preliminary to this policy the Director of Research had prepared a statement, which was tabled, of the publications of the Scheme to date and he would present for discussion at the next meeting a statement of the major experiments in progress or contemplated. The Chairman continued that it was hoped that the Board Members would thus feel that they were not concerned merely with passing the necessary financial resolutions, but also with exercising their function of deciding the technical policy of the Scheme.

Dr. Child, in connection with the publications of the Scheme, said that it was his opinion, as the Scheme's Director of Research that the Scheme is somewhat too small to undertake the regular publication of a journal of its own, and the policy had been to publish articles in "The Tropical Agriculturist" and elsewhere and to issue reprints of these articles. The publication of a series of popular leaflets had been recently commenced, and also of a series of notes in "The Tropical Agriculturist" on matters of interest which could not be incorporated in longer articles. Occasional bulletins are published when the matter cannot be compressed into a leaflet.

Dr. Peries remarked and the Board agreed that the publication of a regular bulletin would be hardly practicable. Mr. Cheyne enquired upon what principle publications were sent out. Dr. Child said that publications were sent to all *bona fide* enquirers who registered their names ; at present the mailing list approached 200. With particular reference to the leaflets, he said, the Press had been very good in giving publicity to the series. Mr. Cheyne and other members thought that further useful distribution of publications could be obtained by a paid advertisement in the Press, particularly in the case of vernacular versions of the leaflets in the Vernacular Press. Further the Government Agents and the Divisional Agricultural Associations would be useful means of approach. Dr. Child said that he had taken notice of these suggestions and would do all he could to ensure as wide a sphere of usefulness as possible for publications of the Scheme.

Mr. Pieris' Booklet.—At Dr. Child's suggestion, the Board approved that Mr. Pieris should be allowed 25 free copies of his booklet for his personal use, and also expressed their willingness to agree to a further personal allowance if Mr. Peiris wished. The Director of Research was authorised to send complimentary copies at his discretion to official bodies in Ceylon and overseas with whom the Scheme was on exchange terms.

The Board decided to fix a price of Re. 1·50 (2/3 English currency) for the booklet. Some discussion took place on means of publicity from the booklet. Dr. Child said that copies had been sent to the Press, who had given good notices. Mr. Cheyne thought that here again a paid advertisement would be useful ; other suggestions were made, including an approach to hotels where the booklet might be brought to the notice of tourists, and the Board agreed that in all cases they would be willing to allow the usual trade discount.

Dr. Child was authorised to act on the suggestions made and undertook to ensure as much publicity as possible.

Mr. Wace de Niese desired it to go on record that the Ceylon Coconut Board had agreed to meet a share of the cost of publication. The Director of Research said that he had written to the Manager of the Coconut Board in September saying that, in his opinion, it would be more satisfactory if sole publication was undertaken by one body, and that receiving no comment on this part of his letter, he had assumed that this met with the approval of the Coconut Board. He thought it likely that the Coconut Research Scheme Board would be willing to allow the Coconut Board as many copies as they required for the cost of publication and the final result would be the same financially as if joint publication by the two bodies had been undertaken.

MISCELLANEOUS

Sale of seed-nuts and seedlings.—The Director of Research said that he thought it advisable to increase the price of seed-nuts and seedlings from January 1, 1937, in view of the fact that the present prices had originally been decided upon when copra prices were considerably lower. In the case of seedlings such careful selection was done in the nursery that approximately only 50 per cent. of the nuts put down in the nursery were ultimately sold as seedlings and the present price of 15 cents each was clearly disproportionately low.

It was unanimously decided to increase prices from January 1, 1937 to 10 cents per seed-nut and 20 cents per seedling. Prices for enquirers outside Ceylon were unaltered.

OTHER BUSINESS

Manurial Experiments.—The Chairman said that the Director of Research had raised one or two points involved when experiments were contemplated on property other than the Scheme's own land. The Scheme would in such cases have to undertake any extra expenses involved in fencing the blocks, marking the trees, weighing nuts, etc. but the actual cost of fertilizers was in a somewhat different category, and the suggestion had been made by the Director of Research that, since the Estate presumably obtained the benefit of any fertilizers applied, it would not be unreasonable to propose that the expense on fertilizers should be shared equally by the Scheme and the Estate.

Further it would be advisable to get an undertaking once an experiment had been commenced on an outside Estate, that it would be allowed to continue for at least four years and that the records should be kept confidential pending the Scheme's publication.

Mr. Cheyne suggested that it would be useful before the Board came to any decision on these matters if Dr. Child could obtain the views of the planters which could well be done by discussion at meetings of various Planters' Associations. The Board considered this a good suggestion and Dr. Child undertook to consult the Planters' Associations and later to bring the matter again before the Board.

REVIEW

VILLAGE WASTE

THE last issue of the Empire Journal of Experimental Agriculture* contains an article by R. C. Wood of the Imperial College of Tropical Agriculture, Trinidad, on the subject of "Village Waste." In this is described the experimental work done in Trinidad on the utilisation of village refuse for compost manufacture on lines similar to those adopted in India and more recently in Ceylon. The present method differs from its predecessors in the respect that the activator used is partially-decomposed refuse and not cattle manure or night soil. The raw material consisted of house garbage, street refuse and hedge trimmings.

The process was briefly as follows : The refuse was carted to a central depot where inert material like tins and iron utensils, bottles, etc. which formed a large proportion of the mass was picked out and buried in deep pits. The residue was then well mixed with its own bulk of material which had been decomposing for at least a week and made into heaps $10' \times 3' \times 3'$ on either side of a central track 12 ft. wide. Every subsequent week each heap was divided ; one half was transferred to a second row of heaps and the other mixed with fresh material. Material from the second row of heaps was in turn transferred to a third row of heaps, whence it was carted to a dump where it was allowed to undergo further decomposition. The essential stages of the manufacture were completed in four weeks. Water was added to keep the heaps moist and to promote decomposition when the rainfall was insufficient.

The disadvantage of the system is that the depot occupies a considerable area, but this is unavoidable as too large heaps retard decomposition.

From 988 tons of rubbish about 15 per cent. or 159 tons of finished or partially-finished compost were obtained. There was a great variation in the quality of the compost. On the average, its analysis was as follows : 19 per cent. organic matter, 25 per cent. moisture and 28 per cent. ash (largely sand). The nitrogen, potash and phosphoric acid contents were respectively ·71, ·62 and ·36 per cent. on oven-dry material. These analytical figures are similar to those of street refuse compost made in Ceylon without night soil.

The cost of production of this compost, which would have been reduced had the work been done on a larger scale, worked out a higher figure than

*Wood, R.C., Village Waste. *Emp. Journ. Expt. Agr.* Vol. IV, No. 16, pp. 357-364, October, 1936.

what it was worth, reckoned purely on its manurial ingredients. The value of the compost is however considerably greater than this, for being a bulky organic manure, it is very desirable under tropical conditions as a supplement to artificial fertilisers.

From the standpoint of sanitary requirements, this system of composting was quite satisfactory as the fly nuisance was very much reduced (though not entirely eliminated) and no complaint was received of objectionable smells.

In a note to this article, R. D. Anstead refers to the great utility of the trials and discusses the question of cost of manufacture in relation to the value of the compost based on its fertilising constituents.—A.W.R.J.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED JANUARY, 1937.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1937	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	18	18	8	..	10	..
	Anthrax	..	..	..	..	..	..
	Rabies	2	2	..	..	..	2
Colombo Municipality	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	8	8	..	1	7	..
	Anthrax	7	7	..	7	..	..
	Rabies	2	2	..	2	..	..
Cattle Quarantine Station	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	2	2	..	2	..	..
Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	64	64	9	1	54	..
	Anthrax	..	..	..	..	..	..
	Piroplasmosis	1	1	..	1	..	..
Southern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
Northern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	306	306	104	14	188	..
	Anthrax	..	..	..	..	..	..
Eastern	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	61	61	61	..	..	..
	Anthrax	..	..	..	..	..	..
North-Western	Rinderpest	7	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
	Rabies	2	2	..	..	..	2
North-Central	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	22	22	18	..	4	..
Uva	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	80	80	42	3	35	..
Sabaragamuwa	Rinderpest	..	..	..	..	..	..
	Foot-and-mouth disease	..	..	..	..	..	..
	Anthrax	..	..	..	..	..	..
	Piroplasmosis	4	4	1	1	2	..

Department of Agriculture,
Peradeniya, 23rd February, 1937

M. CRAWFORD,
Deputy Director of Agriculture (Animal Husbandry) & Government Veterinary Surgeon

METEOROLOGICAL REPORT—JANUARY, 1937

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Colombo ..	85·5	−0·7	73·0	+1·1	72	88	5·6	3·43	14	− 0·60
Puttalam ..	84·5	−0·9	70·7	+0·6	76	95	5·4	3.85	15	+ 0·27
Mannar ..	83·0	−0·8	74·7	+0·6	76	84	4·4	3·71	11	− 0·25
Jaffna ..	83·1	+0·3	72·5	+0·3	69	85	7·0	3·36	11	− 0·98
Trincomalee ..	80·5	0	75·6	+0·6	77	79	6·6	8·77	17	+ 0·07
Batticaloa ..	81·7	+0·4	74·1	+0·6	75	86	5·7	15·09	18	+ 1·32
Hambantota ..	84·8	+0·3	72·6	0	76	90	4·5	6·75	13	+ 3·05
Galle ..	83·5	−0·5	73·3	+0·5	76	88	5·4	3·90	12	+ 0·26
Ratnapura ..	88·7	−0·3	71·7	+0·6	72	95	5·8	8·29	16	+ 1·82
Anuradhapura ..	81·4	−1·2	70·6	+1·3	71	95	6·7	8·28	16	+ 2·57
Kurunegala ..	85·7	−0·3	70·4	+0·6	71	93	5·0	8·56	13	+ 3·69
Kandy ..	83·1	+0·7	67·7	+0·4	72	90	5·4	9·14	16	+ 2·48
Badulla ..	76·3	+0·3	65·3	+1·7	78	92	6·6	9·71	19	− 0·84
Diyatalawa ..	72·0	+0·5	58·1	+0·5	85	97	6·3	6·40	17	+ 0·06
Hakgala ..	66·5	+0·7	52·0	−0·2	86	94	7·8	13·96	23	+ 1·83
Nuwara Eliya ..	68·8	+1·5	47·8	+1·0	76	93	7·8	10·39	17	+ 3·65

The rainfall of January was appreciably above normal on the northern and north-eastern slopes of the hills, and in the extreme south-western corner of the Island. The excesses reported, however, rarely exceeded 5 inches, except on the north-eastern slopes of the Knuckles range, where Dooroomadella was 26·44 inches above average, and other stations generally reported excesses of 5 to 20 inches. A few stations on the south-east coast also reported excesses of 5 to 10 inches. In the remainder of the Island excesses and deficits were both generally small, deficits predominating in the north.

The highest monthly totals reported were 53·11 inches at Hendon, 52·77 inches at Dooroomadella, and 50·60 inches at Upper St. Martin's.

60 daily falls of over 5 inches in a day were reported, most of them for the 15th or 19th, and on or near the north-eastern slopes of the hills. The highest daily fall reported was 11·30 inches, at Hendon, on the 19th, and daily falls of 10 inches or over were also reported from eight other stations, nearly all for the 15th or 19th.

During the greater part of January the weather remained of the usual north-east monsoon type, with monsoon rains in the east and north-east of Ceylon, and local rains, sometimes accompanied by thunder, in the lee of the hills. There was particularly heavy widespread rain, on both sides of the hills, but particularly on their eastern and north-eastern slopes, on the 15th and 19th. About the 21st the weather changed, and a dry spell set in. Humidity was low, and there was very little rain reported, while, as a result of the increased radiation at night, night temperatures were appreciably below normal, particularly in the hills, ground frost being reported at Nuwara Eliya on several occasions. These conditions lasted until the 28th, after which conditions reverted to the usual north-east monsoon type, with increased humidity and rainfall.

Mean temperatures for the month were generally about normal by day, and a little above normal by night. Mean humidities showed no marked deviations from normal, while cloud was a little above normal. Barometric pressure was below normal, the gradient being a little steeper than usual, while winds at the coast were generally a little above normal. Wind directions were generally N.E. to N.N.E.

H. JAMESON,
Superintendent, Observatory.